Instruction Report ITL-96-2
June 1996

US Army Corps of Engineers
Waterways Experiment Station

Computer-Aided Structural Engineering (CASE) Project

Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 4
Scheme B

by David Wickersheimer, Carl Roth, Gene McDermott
Wickersheimer Engineers, Inc.

WES

Prepared for Headquarters, U.S. Army Corps of Engineers

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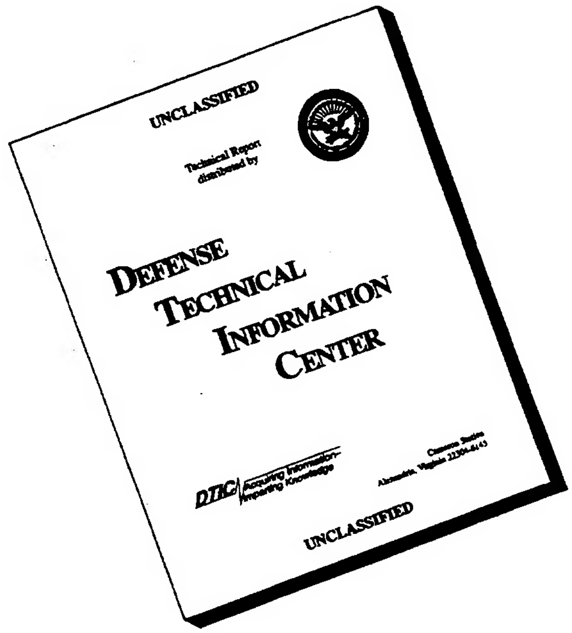

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by David Wickersheimer, Carl Roth, Gene McDermott

Wickersheimer Engineers, Inc.
821 South Neil Street
Champaign, IL 61820

Report 4 of a series

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Washington, DC 20314-1000

Monitored by U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

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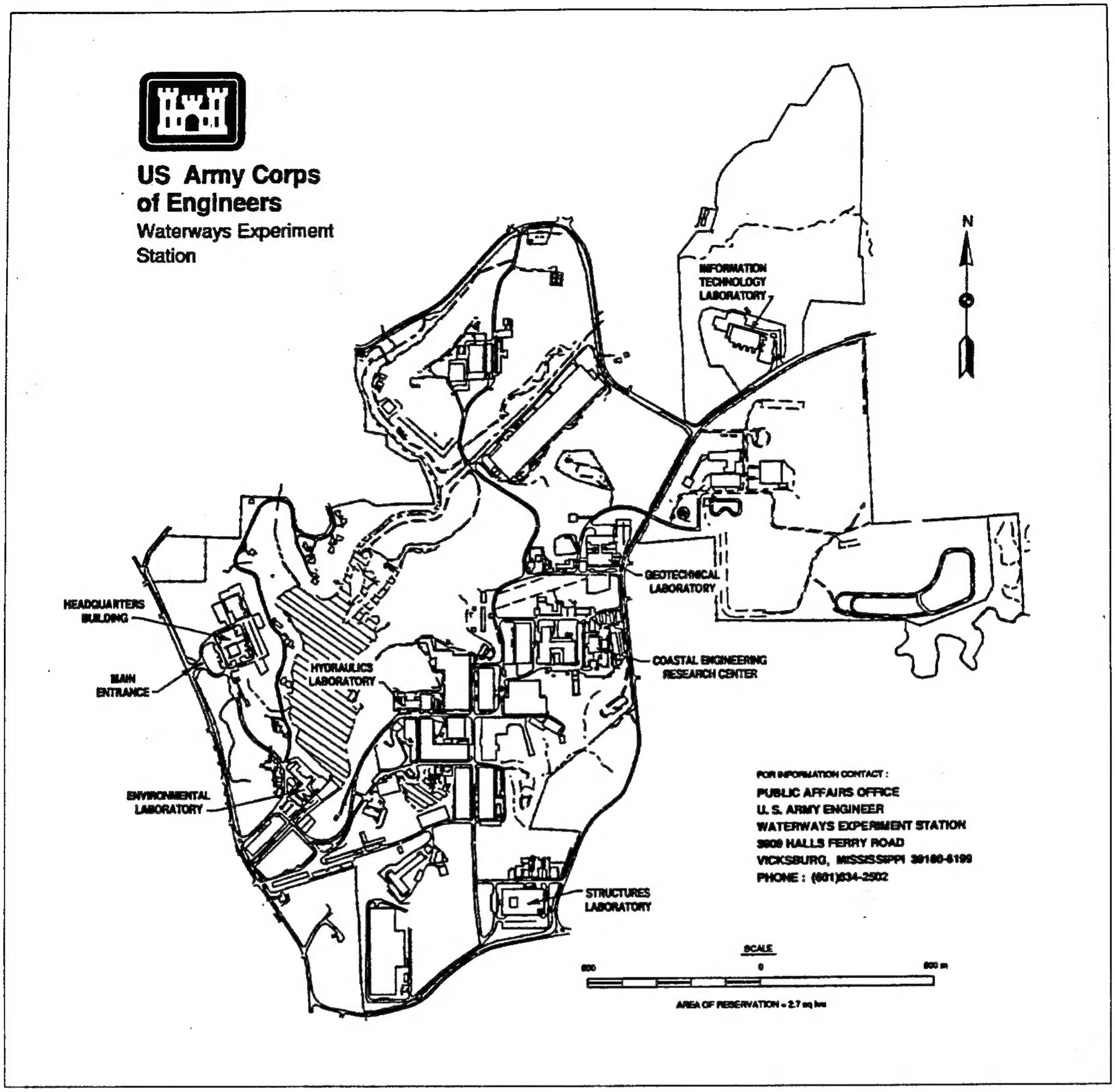

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TA7 W34i no.ITL-96-2 rept.4

PREFACE

This report describes the computer program CASM, which is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics, to describe the structural framing scheme for X-braced frames that are all steel, composite, with lateral load resistance. Funds for the development of this program and publication of this user's guide were provided to the Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

Specifications for the program were provided by members of the Building Systems Task Group of the CASE Project. The following were members of the task group during program development:

- Mr. Dan Reynolds, U.S. Army Engineer (USAE) District, Sacramento (Chairman)
- Ms. Anjana Chudgar, USAE Division, Ohio River
- Mr. Pete Rossbach, USAE District, Baltimore
- Mr. Dave Smith, USAE District, Omaha
- Mr. Mark Burkholder, USAE District, Tulsa
- Mr. Jerry Maurseth, USAE District, Portland
- Mr. Chris Merrill, WES
- Mr. Michael Pace, WES

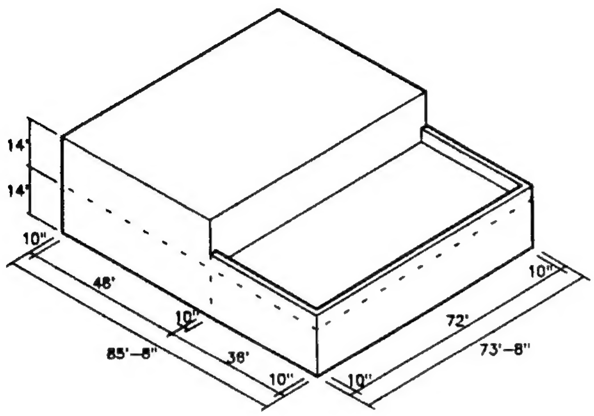
The computer program and report were written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

The work was monitored at WES by Mr. Michael E. Pace and Mr. Chris Merrill, Computer-Aided Engineering Division (CAED), under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; Dr. Reed Mosher, Chief, CAED; Mr. Timothy Ables, Assistant Director, ITL; and Dr. N. Radhakrishnan, Director, ITL. Mr. Donald Dressler was the original HQUSACE point of contact, and Mr. Charlie Gutberlet is the present technical monitor.

Dr. Robert W. Whalin is Director of WES. COL Bruce K. Howard, EN, is Commander.

Table of Contents

Project Description



This 1 and 2 story project is to provide approximately 9,500 gross square feet of office space for one of two possible sites:

(a) Charleston, South Carolina

(b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

1. The 36' x 72' space on the first level shall be column free for open office planning.

2. The 48' x 72' first and second floor areas shall provide 24' square bays.

3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.

4. The second floor occupancy live loads located on the plan are:

Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf

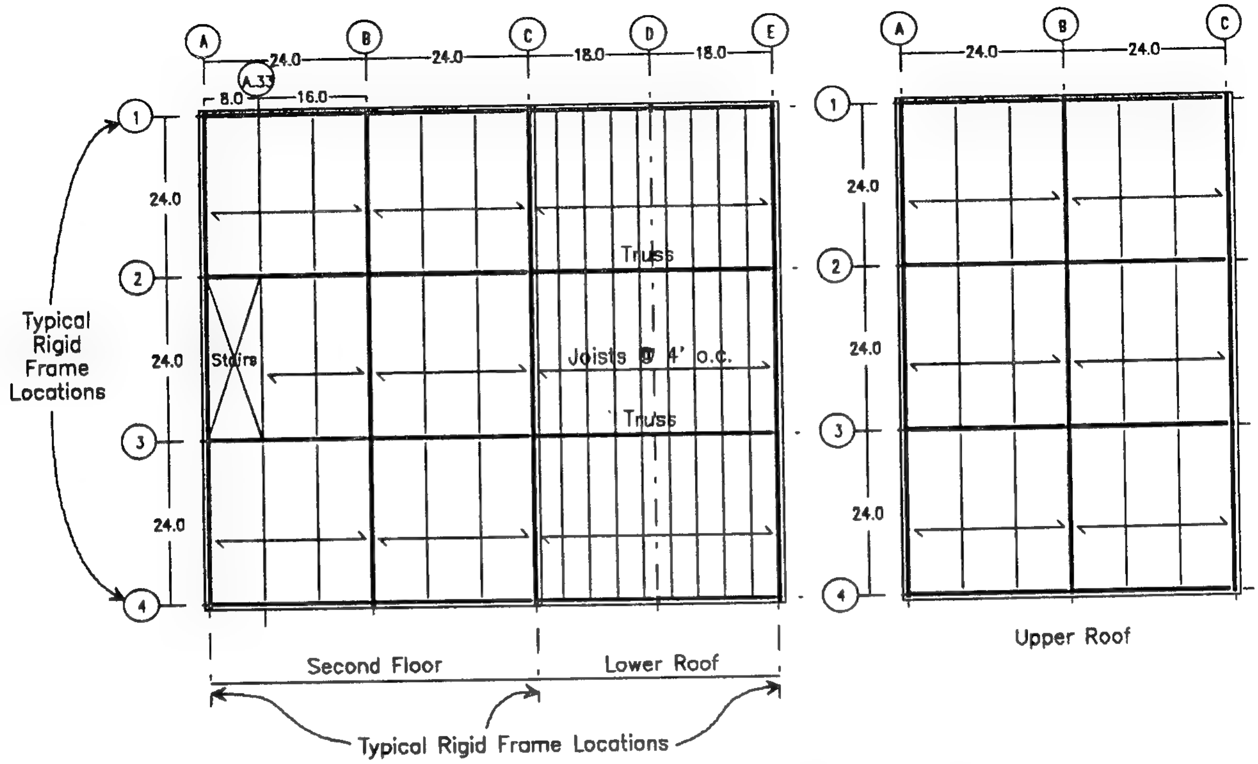
5. Structural framing schemes to be designed and compared shall be as follows:

Scheme A: All steel, non-composite,
lateral load resistance = rigid frames.

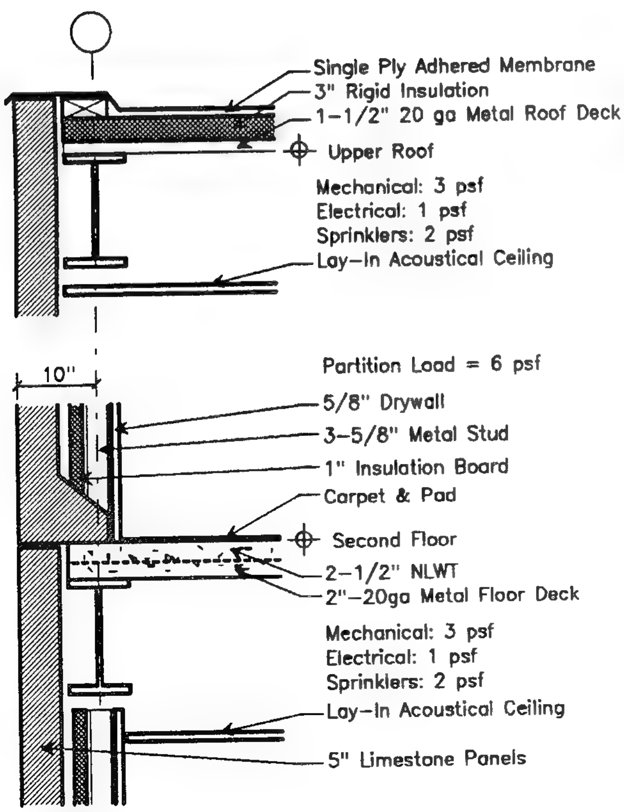
Scheme B: All steel, composite,
lateral load resistance = X braced frames.

Scheme C: Monolithic concrete for two story portion, steel for lower roof portion,
lateral load resistance = shear walls.

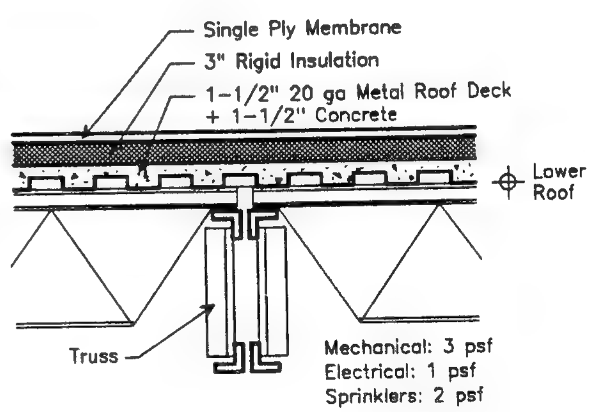
Scheme A



A
B
C
D
E
24.0
18.0
8.0
16.0
A.33
1
2
3
4
Typical Rigid Frame Locations
Stairs
Truss
Joists @ 4' o.c.
Second Floor
Lower Roof
Upper Roof
Typical Rigid Frame Locations

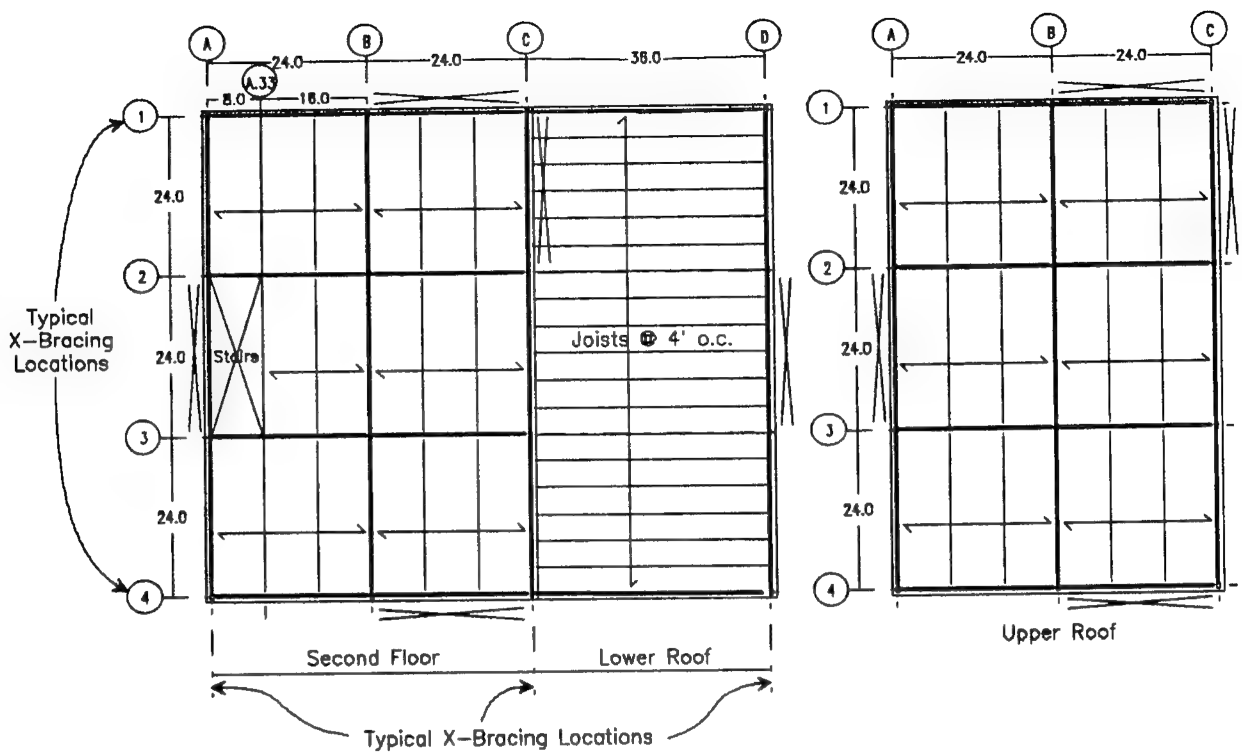


Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels

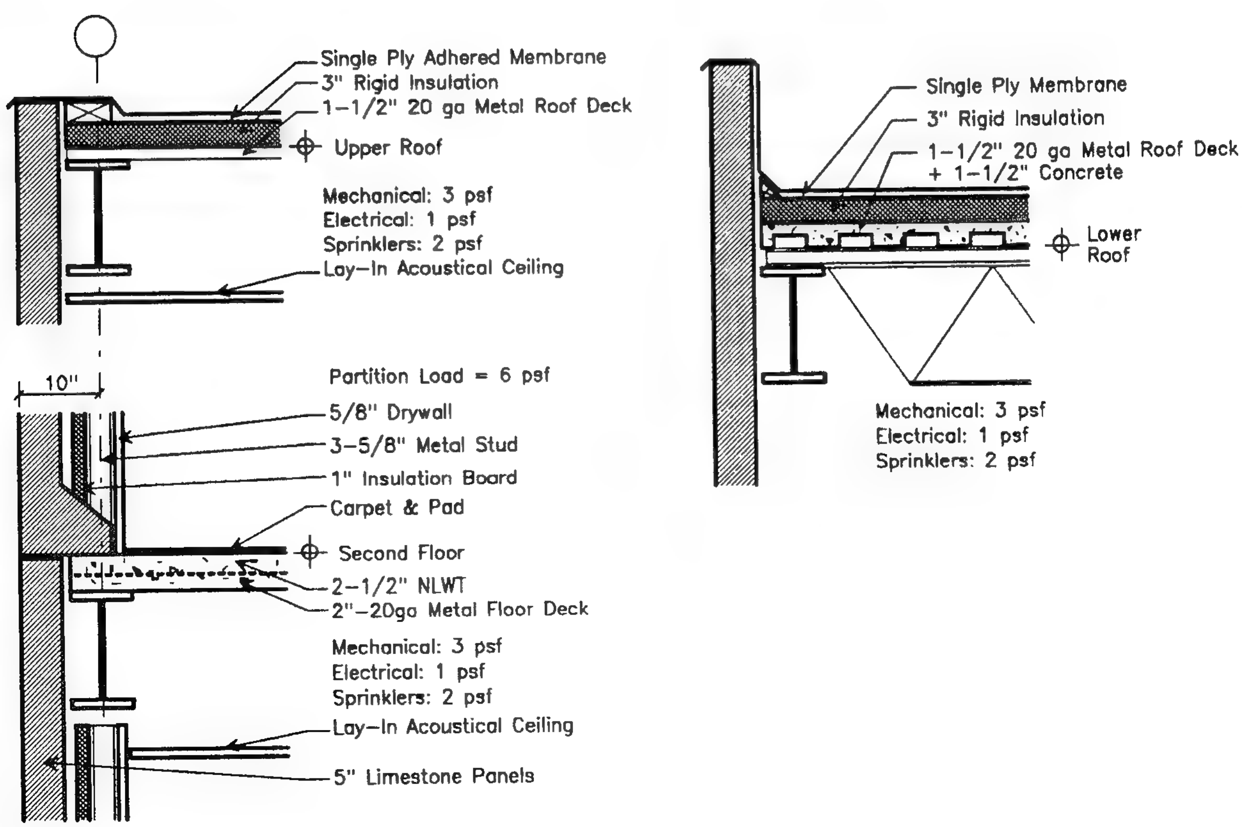


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck + 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

Scheme B

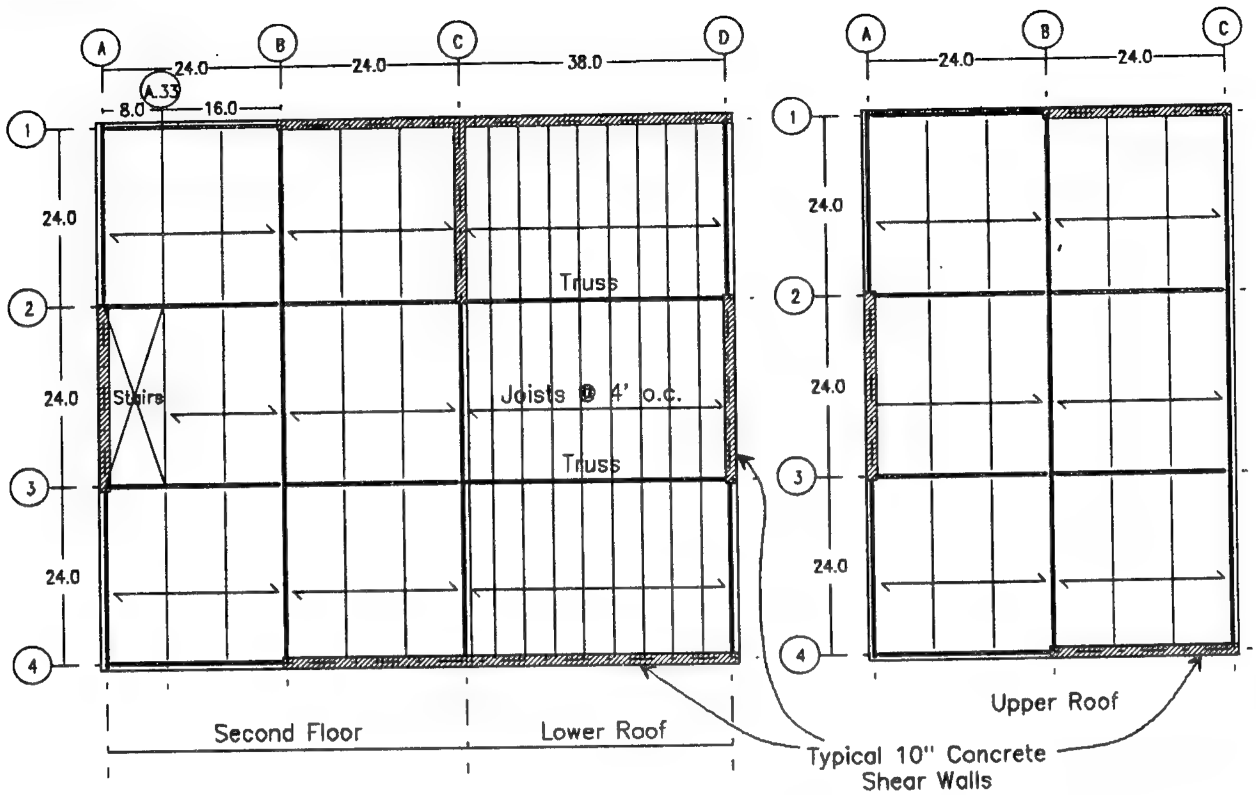


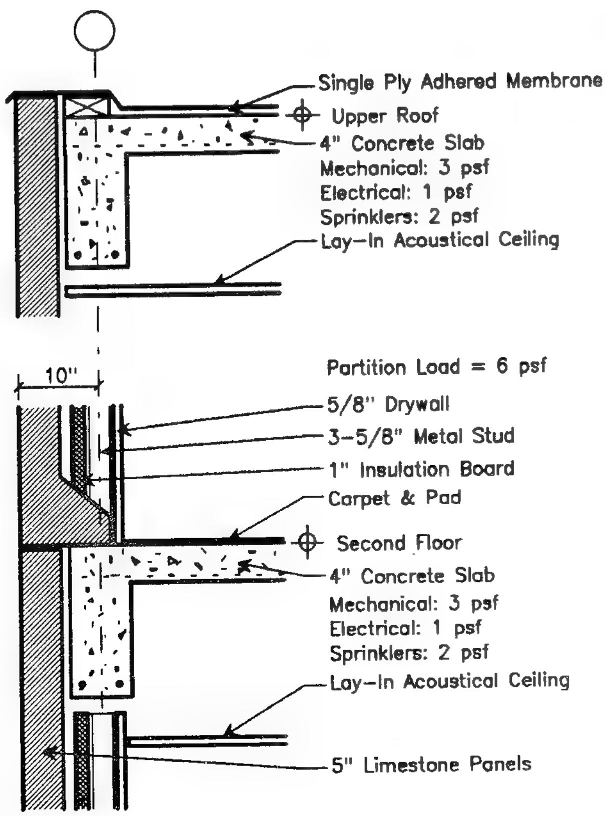
A
B
C
D
A.33
24.0
36.0
8.0
16.0
1
2
3
4
Typical X-Bracing Locations
Stairs
Joists @ 4' o.c.
Second Floor
Lower Roof
Typical X-Bracing Locations
Upper Roof

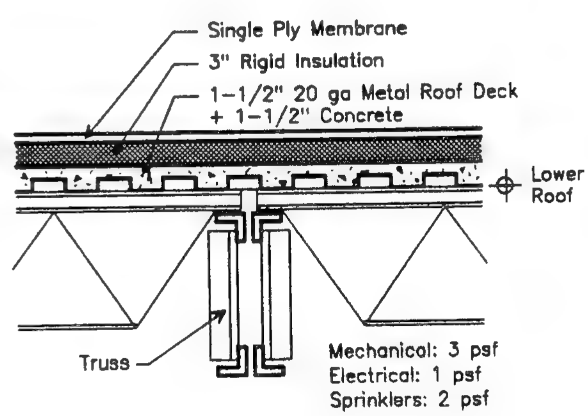


Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels
Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

Scheme C


A
B
C
D
24.0
24.0
38.0
A.33
8.0
16.0
1
2
3
4
Truss
Stairs
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Upper Roof
Typical 10" Concrete Shear Walls


Single Ply Adhered Membrane
Upper Roof
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck + 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

6. The typical exterior envelope consists of 5" limestone panels, 1" rigid insulation, 3-5/8" metal studs, and 5/8" drywall.

7. Window and door openings are uniformly distributed to all elevations.

8. Load Assumptions:

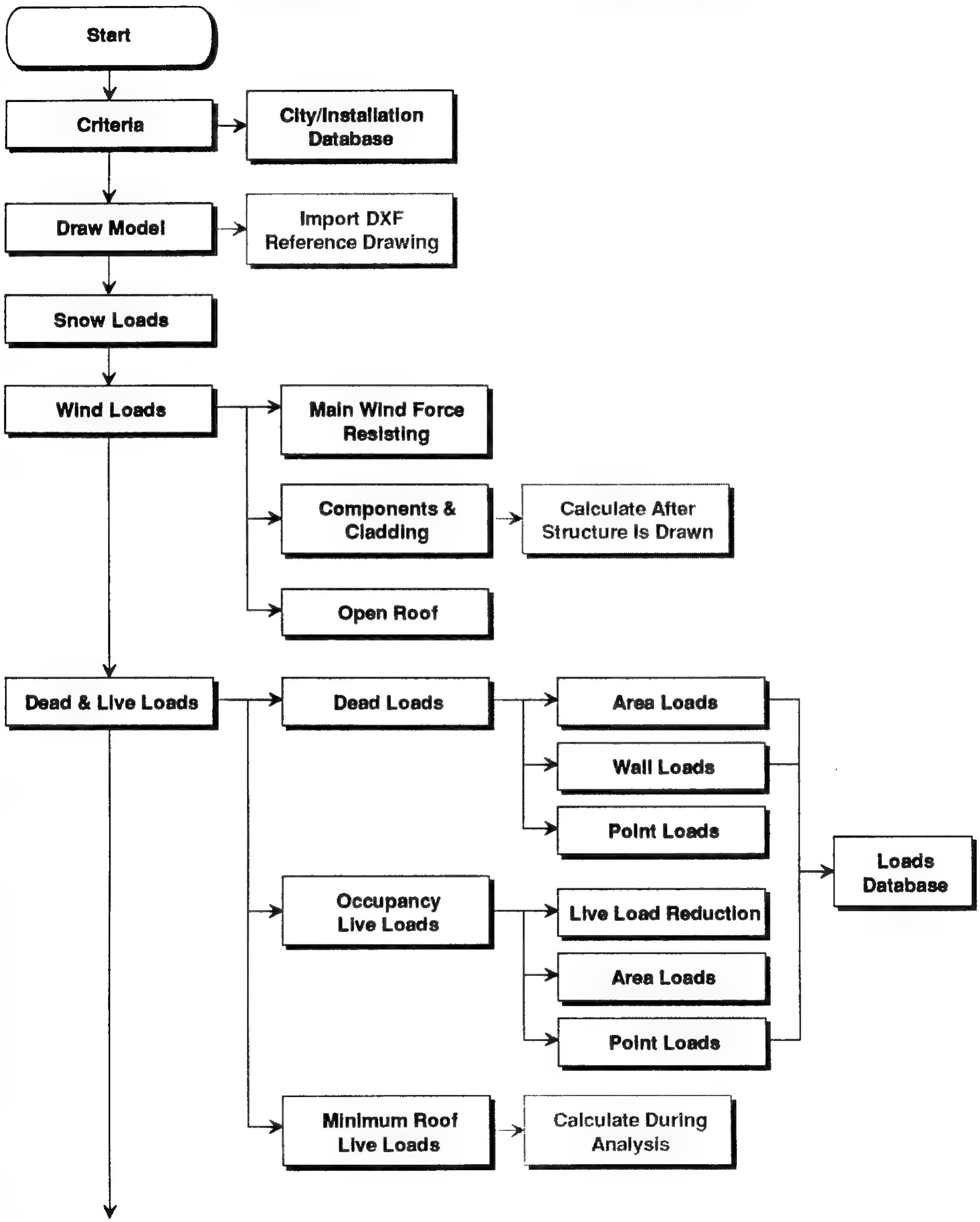
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

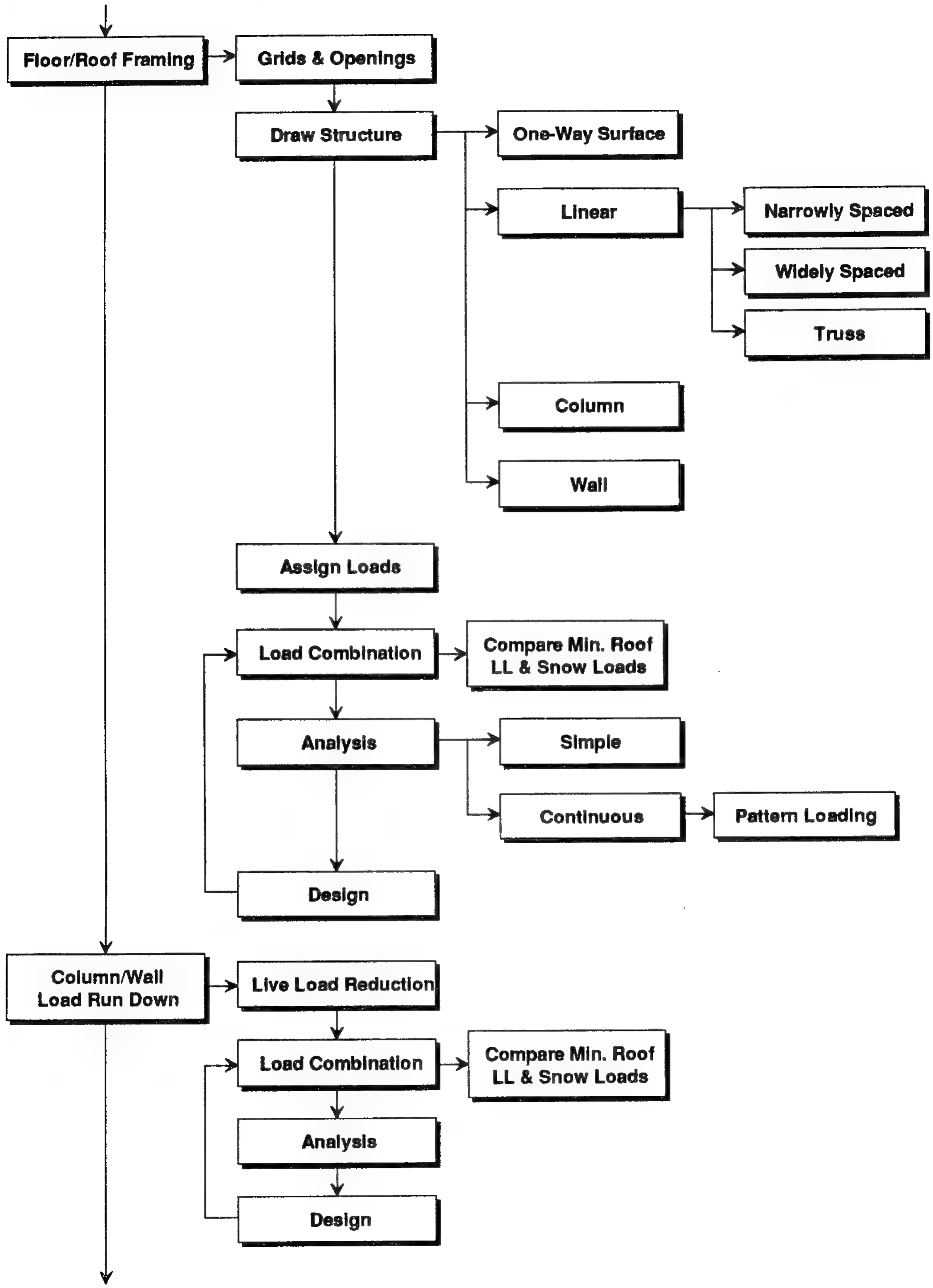
9. Material Assumptions:

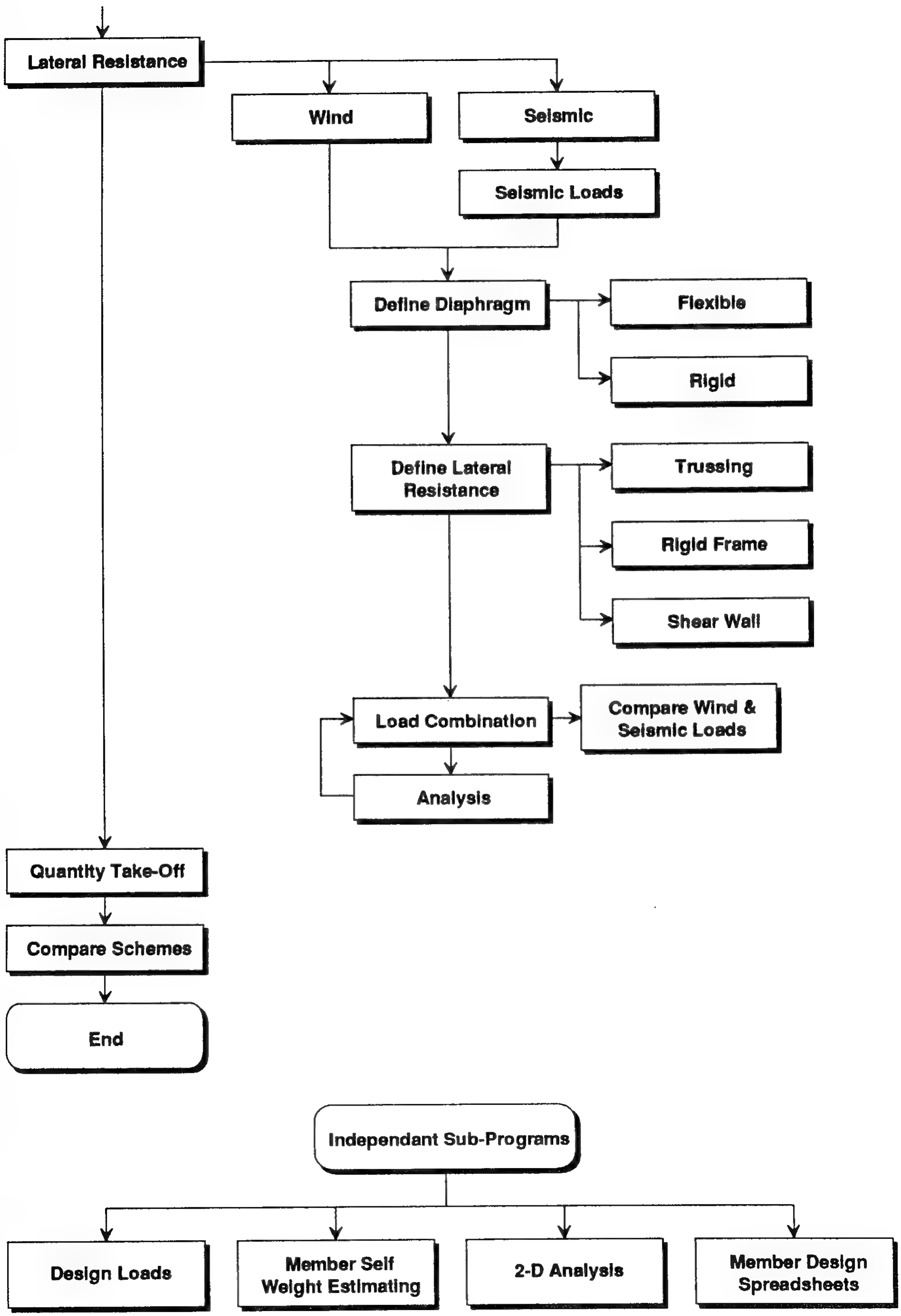
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

10. Fire resistance rating shall be achieved by a wet sprinkler system.

Computer Aided Structural Modeling




Floor/Roof Framing
Grids & Openings
Draw Structure
One-Way Surface
Linear
Narrowly Spaced
Widely Spaced
Truss
Column
Wall
Assign Loads
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Simple
Continuous
Pattern Loading
Design
Column/Wall Load Run Down
Live Load Reduction
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Design


Lateral Resistance
Wind
Seismic
Seismic Loads
Define Diaphragm
Flexible
Rigid
Define Lateral Resistance
Trussing
Rigid Frame
Shear Wall
Load Combination
Compare Wind & Seismic Loads
Analysis
Quantity Take-Off
Compare Schemes
End
Independant Sub-Programs
Design Loads
Member Self Weight Estimating
2-D Analysis
Member Design Spreadsheets

Criteria

Start

Use Criteria Menu

Project

Project Data

Project Name:	Office Building - Scheme B
City/Installation:	Radford AAP
Country:	USA
State:	VA
County:	Pulaski
Design Load:	TM 5-809-1 1992
Building Code:	BOCA
Seismic Code:	TM 5-809-10 1992
Elevation Above Sea Level:	3300 ft
No. Of Stories:	2
Floor Area:	9504 sq ft
Occupancy:	Use Group B
Type Const:	3A
Seismic Lateral Load Resistance	
N-S System:	Blank
E-W System:	Blank

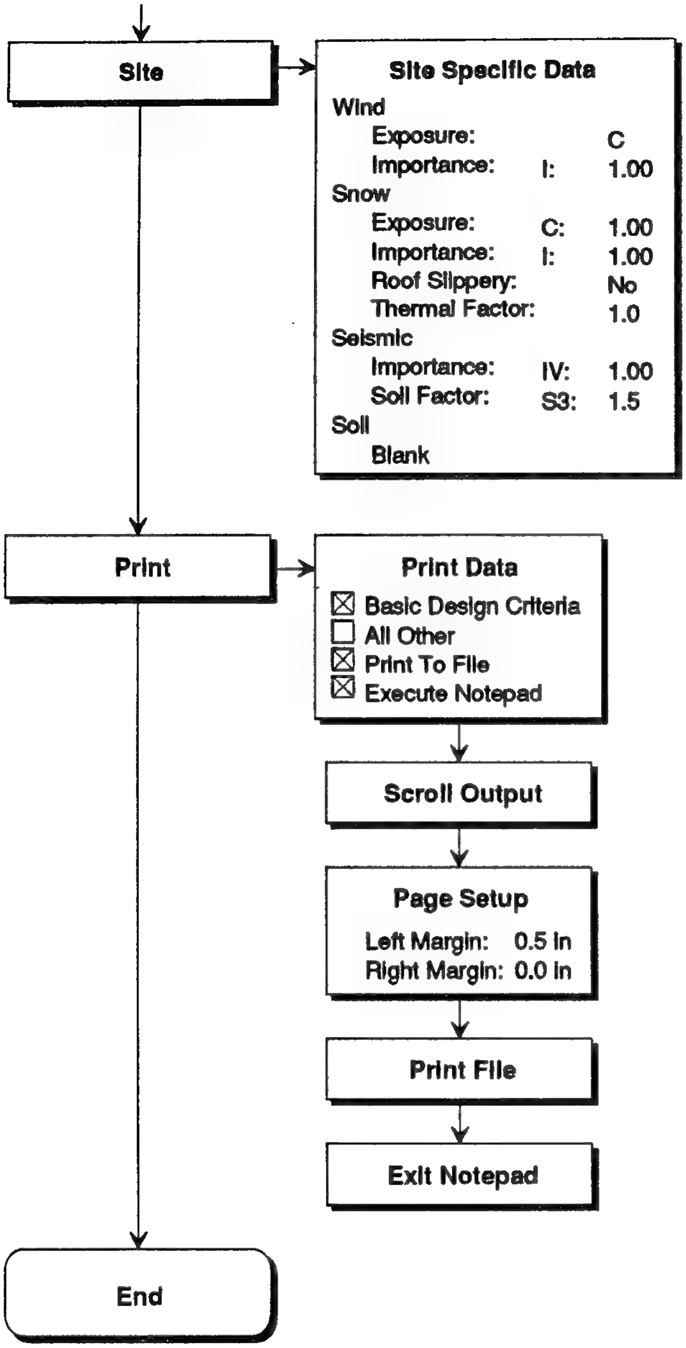
City/Installation

Select Radford AAP From List

Regional

Review Regional Data

Wind		
Basic Wind Speed:	70.0	mph
Coastal:	No	
Maximum Wind Speed:	58.0	mph
Wind Direction:	SE	
Snow		
Ground Snow Load:	25.0	psf
Maximum Snow Depth:	15.0	in
Snow Density:	17.3	pcf
Rain		
Average Annual Rainfall:	44.0	in
Maximum Rainfall:	4.0	in
Temperature		
Maximum temperature:	92	°F
Minimum Temperature:	-24	°F
Seismic Zone: 2A:	0.150	
Frost Depth:	22	in


Site
Site Specific Data
Wind
Exposure: C
Importance: I: 1.00
Snow
Exposure: C: 1.00
Importance: I: 1.00
Roof Slippery: No
Thermal Factor: 1.0
Seismic
Importance: IV: 1.00
Soil Factor: S3: 1.5
Soil
Blank
Print
Print Data
☒ Basic Design Criteria
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Basic Design Criteria

Project Data

Project Name	: Office Building - Scheme B
City/Installation	: Radford AAP
Country	: USA
State	: VA
County	: Pulaski
Design Load	: TM 5-809-1 1992
Building Code	: BOCA
Seismic Code	: TM 5-809-10 1992
Elevation Above Sea Level	: 3300 ft
No. of Stories	: 2
Floor Area	: 9504 sqft
Occupancy	: Use Group B
Type of Construction	: 3A
Seismic Lateral Load Resistance	
N-S System	:
N-S Rw	: 0
E-W System	:
E-W Rw	: 0

Regional Data

Wind	
Basic Wind Speed From Map	: 70.0 mph
Calculated Wind Speed	: 0.0 mph
Coastal	: No
Maximum Wind Speed	: 58.0 mph
Wind Direction	: SE
Snow	
Ground Snow Load	: 25.0 psf
Maximum Snow Depth	: 15.0 in
Snow Density	: 17.3 pcf
Rain	
Average Annual Rainfall	: 44.0 in
Maximum Rainfall	: 4.0 in
Temperature	
Maximum Temperature	: 92.0 °F
Minimum Temperature	: -24.0 °F
Seismic Zone : 2A	: 0.150
Frost Depth	: 22 in

Site Specific Data

Wind	
Exposure	: C
Importance : I	: 1.00
Snow	
Exposure : C	: 1.00
Importance : I	: 1.00
Roof Slippery	: No
Thermal Factor	: 1.0
Seismic	
Importance : IV	: 1.00
Soil Factor : S3	: 1.5

Notes

Importance Factor for Snow and Wind:

I All buildings and structures except those listed below.

II Buildings and structures where primary occupancy is one in which more than 300 people congregate in one area.

III Buildings and structures designated as essential facilities, including, but not limited to:

- Hospital and other medical facilities having surgery or emergency treatment areas.
- Fire or rescue and police stations.
- Primary communication facilities and disaster operation centers.
- Power stations and other utilities required in an emergency.

Structures having critical national defense capabilities.

IV Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities.

Wind Exposure Category:

Exposure C:

Open terrain with scattered obstructions having heights generally less than 30.0 ft.

Snow Exposure Category:

Exposure C:

Locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby.

* The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

Snow Thermal Factor:

Heated Structure.

* These conditions should be representative of those that are likely to exist during the life of the structure.

Importance Factor for Seismic:

I. Essential Facilities

Hospitals and other medical facilities having surgery and emergency treatment areas.

Fire and police stations.

Tanks or other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.

Emergency vehicle shelters and garages.

Structures and equipment in emergency preparedness centers.

Stand-by power generating equipment for essential facilities.

Structures and equipment in communication centers and other facilities required for emergency response.

II. Hazardous Facilities

Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.

III. Special Occupancy Structure

Covered structures whose primary occupancy is public assembly - capacity more than 300 persons.

Buildings for schools (through secondary) or day-care centers - capacity more than 250 students.

Buildings for colleges or adult education schools - capacity more than 500 students.

Medical facilities with 50 or more resident incapacitated patients, but not included above.

Jails and detention facilities.

All structures with occupancy more than 5000 persons.

Structures and equipment in power generating stations and other public utility facilities not included above, and required for continued operation.

IV. Standard Occupancy Structure

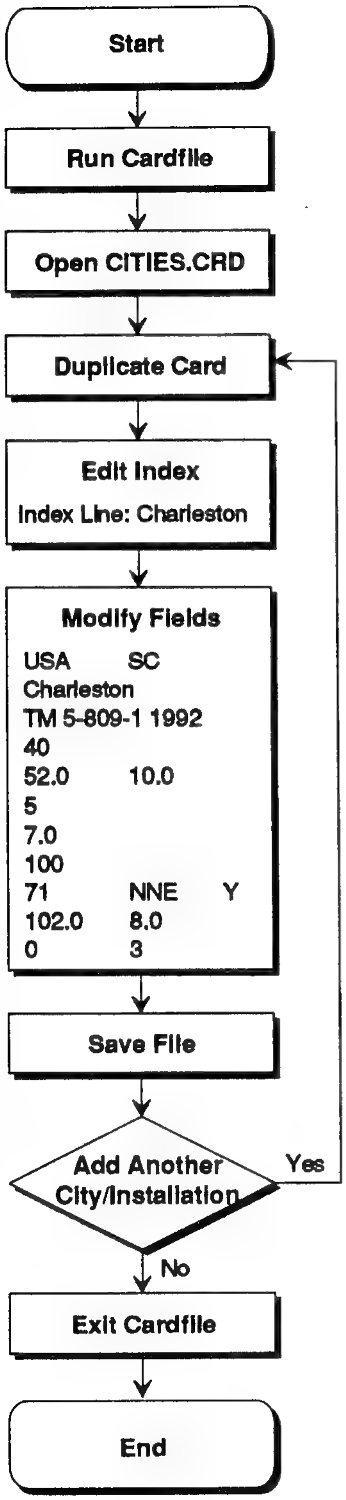
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

S3: A soil profile 70.0 ft or more in depth and containing more than 20.0 ft of soft to medium stiff clay but not more than 40.0 ft of soft clay.

The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines that soil profile S4 may be present at the site, or in the event that soil profile S4 is established by geotechnical data.

City/Installation Database



Fields

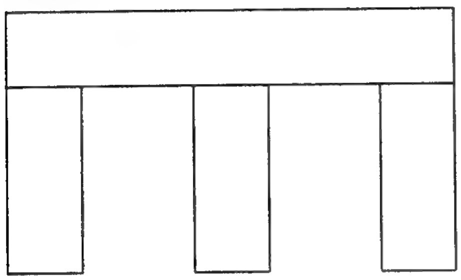
Country	State	*Metric*
County		
Design Load		
Elevation (ft)		
Ave. Rain (in)	Max. Rain (in)	
Ground Snow Load (psf)		
Max. Snow Depth (in)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (in)	Seismic Zone	

Modeling Philosophy

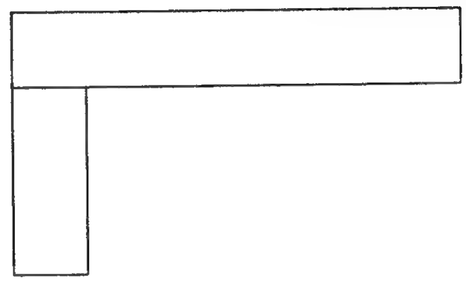
A. Simplify the geometric model

For buildings with repetitive wings, only one wing needs to be modeled.

Insignificant portions such as chimneys, dormers, and small projections, should not be modeled.



Extra wings are not necessary



Simplified model

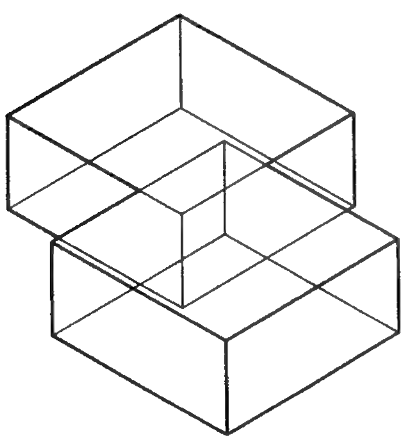
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

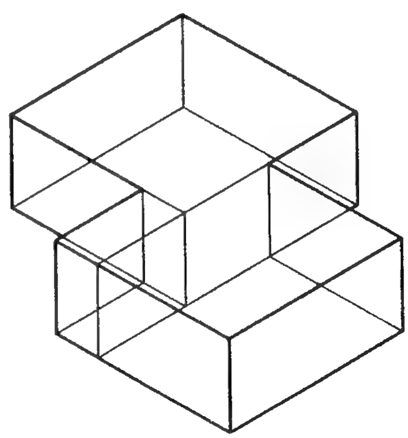
Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

When modeling parapet walls, make sure the corners do not intersect.



Incorrect

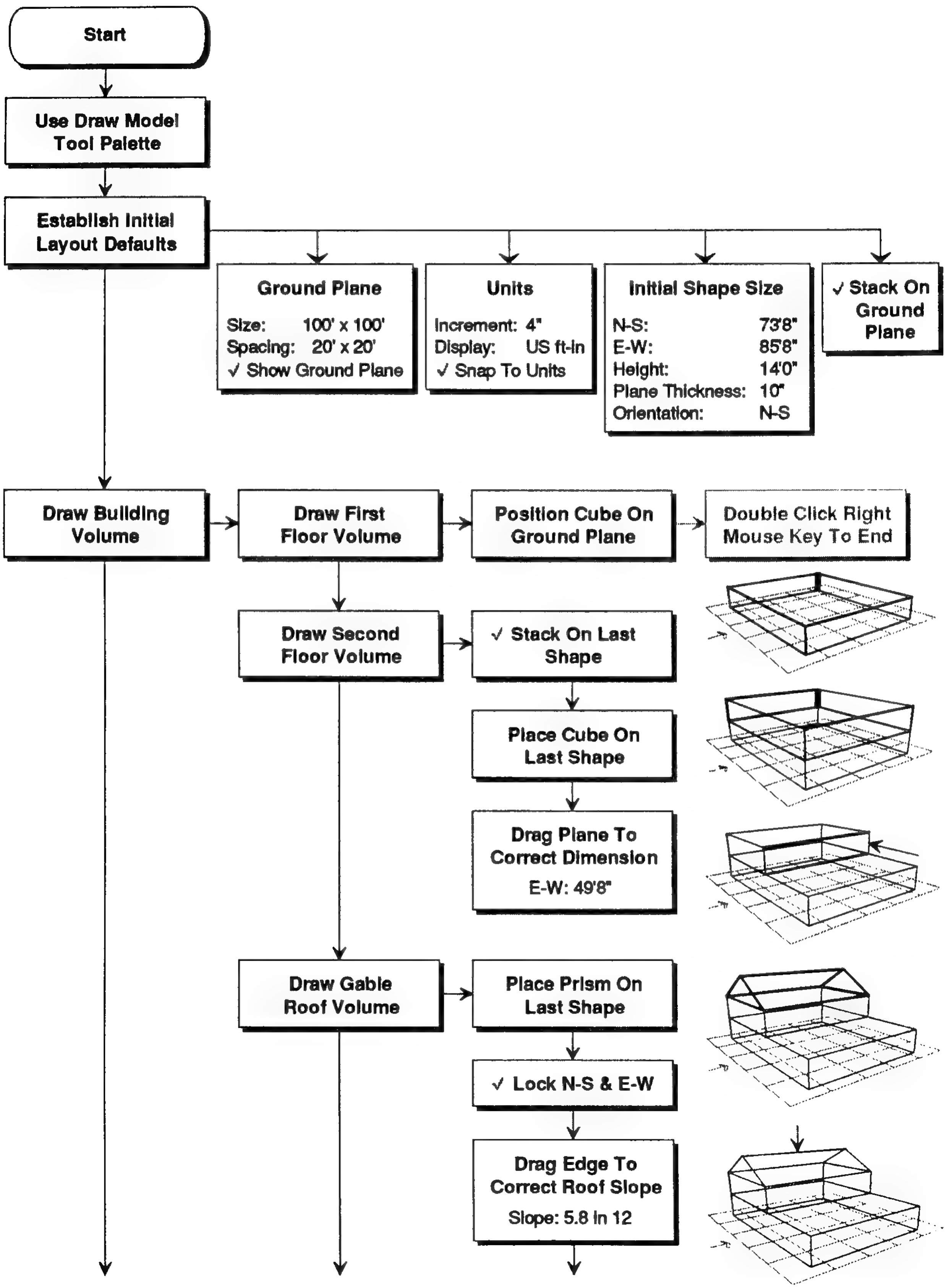


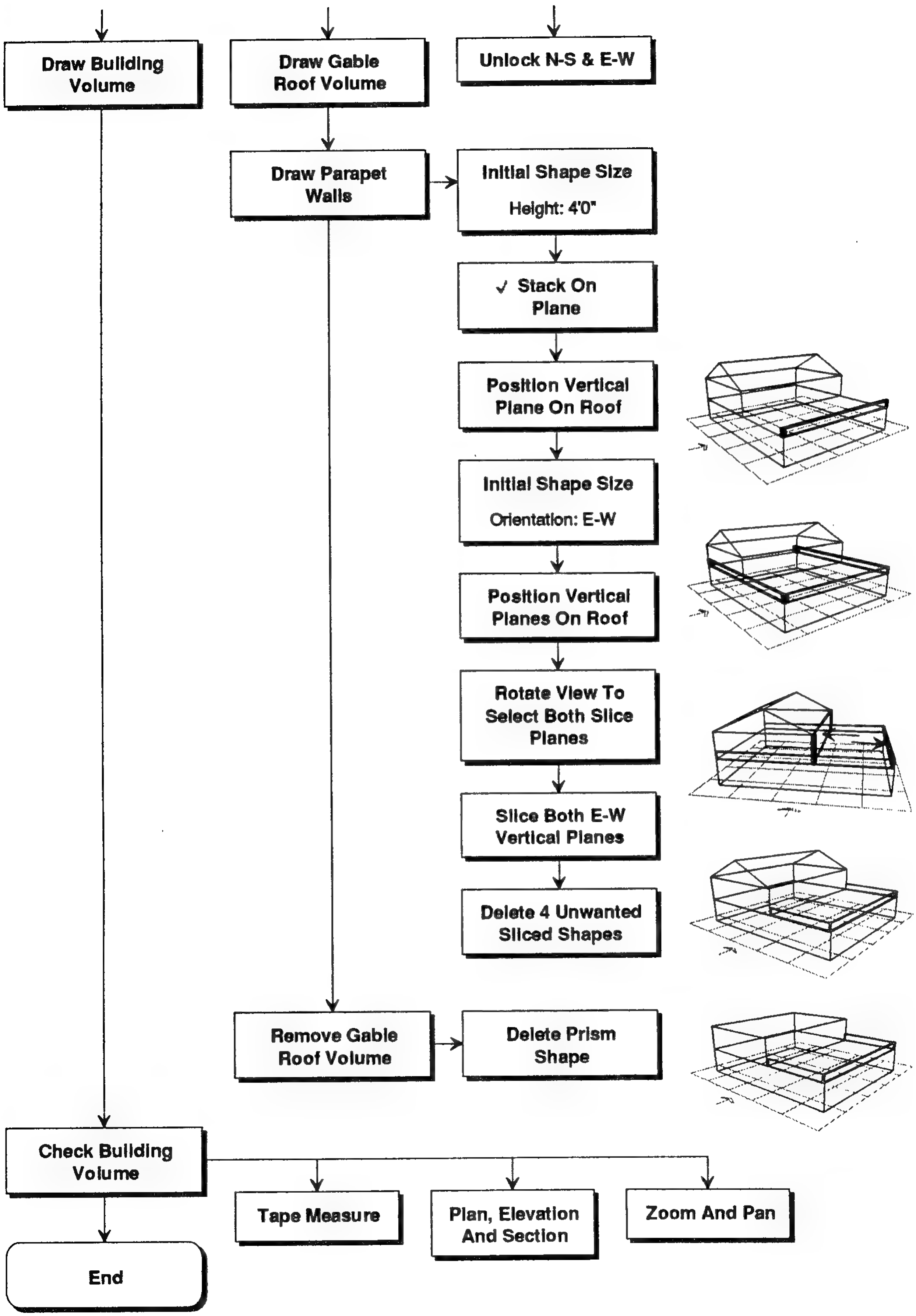
Correct

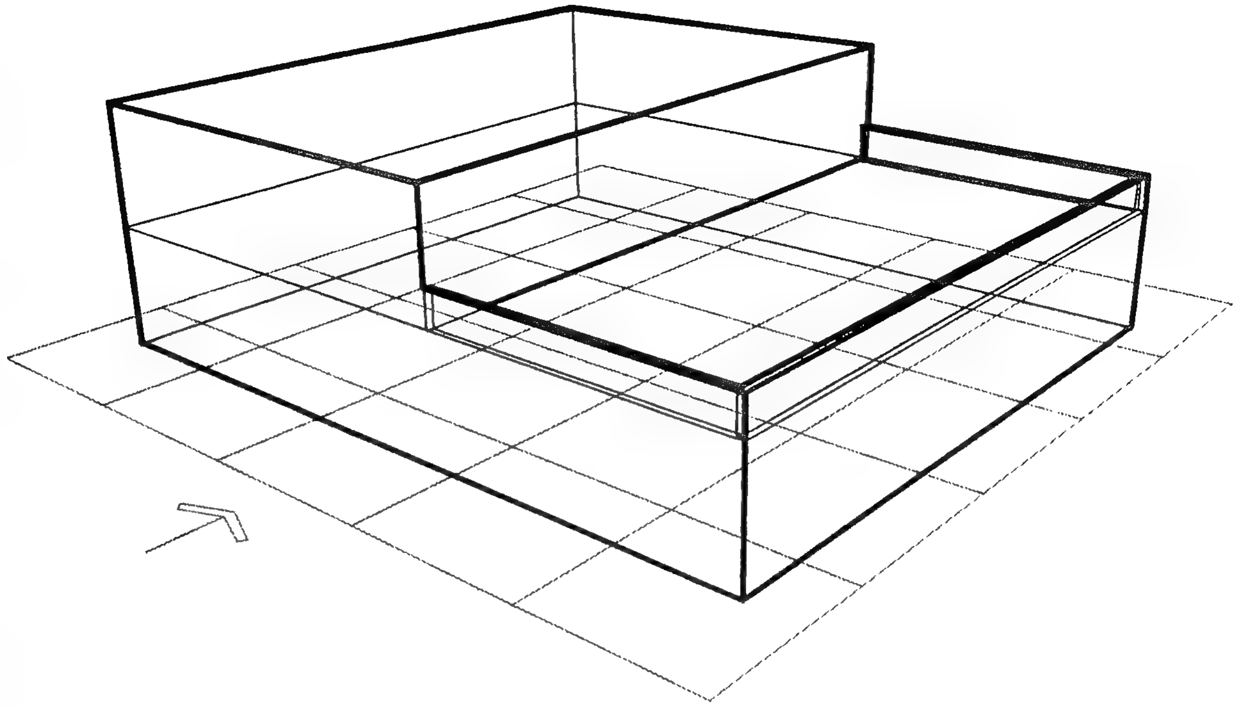
D. Verify the model

Use the Tape Measure command, zoom in on a plan, elevation and 3-D views to verify the model.

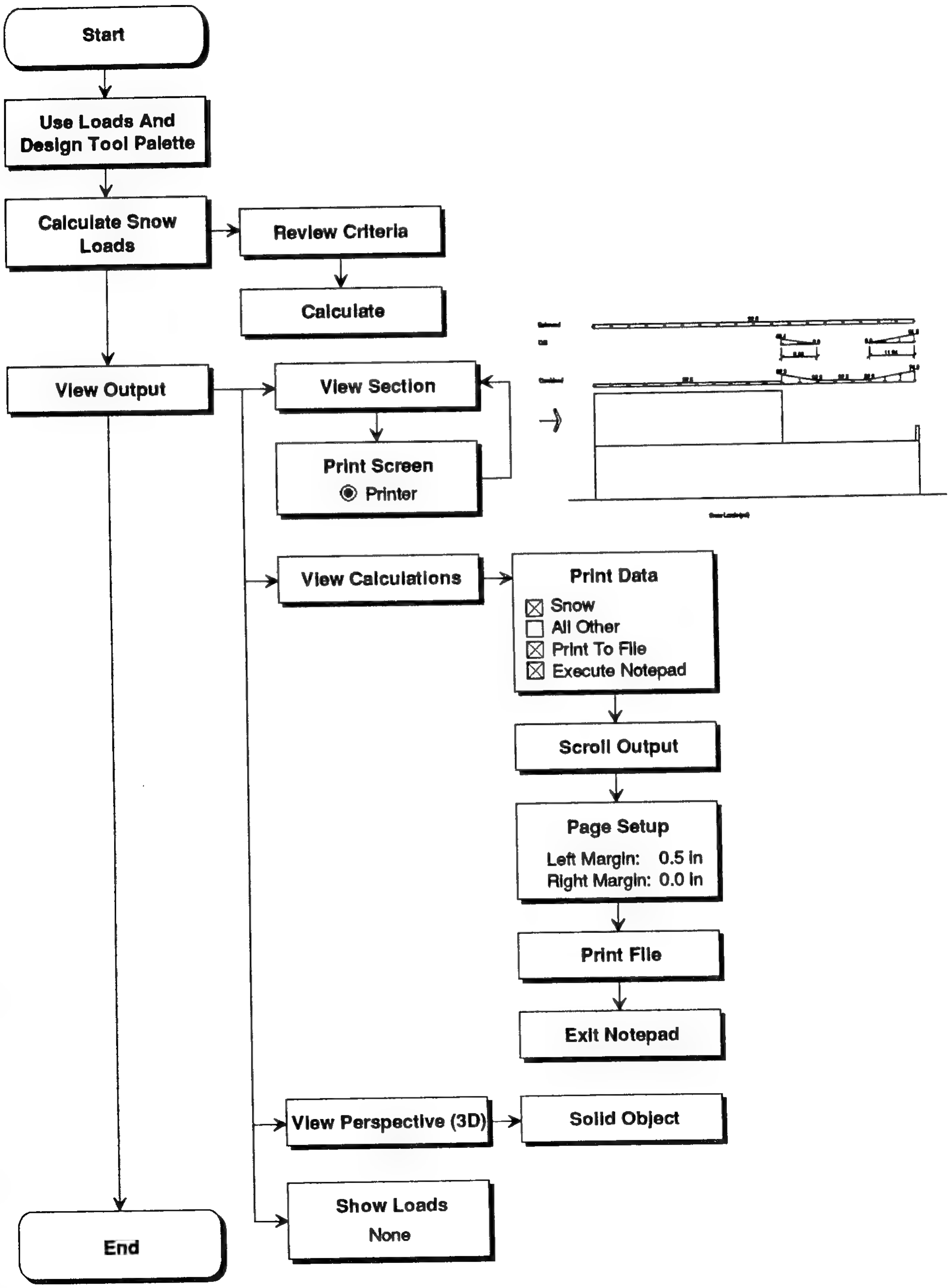
Draw Model


Start
Use Draw Model Tool Palette
Establish Initial Layout Defaults
Ground Plane
Size: 100' x 100'
Spacing: 20' x 20'
✓ Show Ground Plane
Units
Increment: 4"
Display: US ft-in
✓ Snap To Units
Initial Shape Size
N-S: 73'8"
E-W: 85'8"
Height: 14'0"
Plane Thickness: 10"
Orientation: N-S
✓ Stack On Ground Plane
Draw Building Volume
Draw First Floor Volume
Position Cube On Ground Plane
Double Click Right Mouse Key To End
Draw Second Floor Volume
✓ Stack On Last Shape
Place Cube On Last Shape
Drag Plane To Correct Dimension
E-W: 49'8"
Draw Gable Roof Volume
Place Prism On Last Shape
✓ Lock N-S & E-W
Drag Edge To Correct Roof Slope
Slope: 5.8 in 12

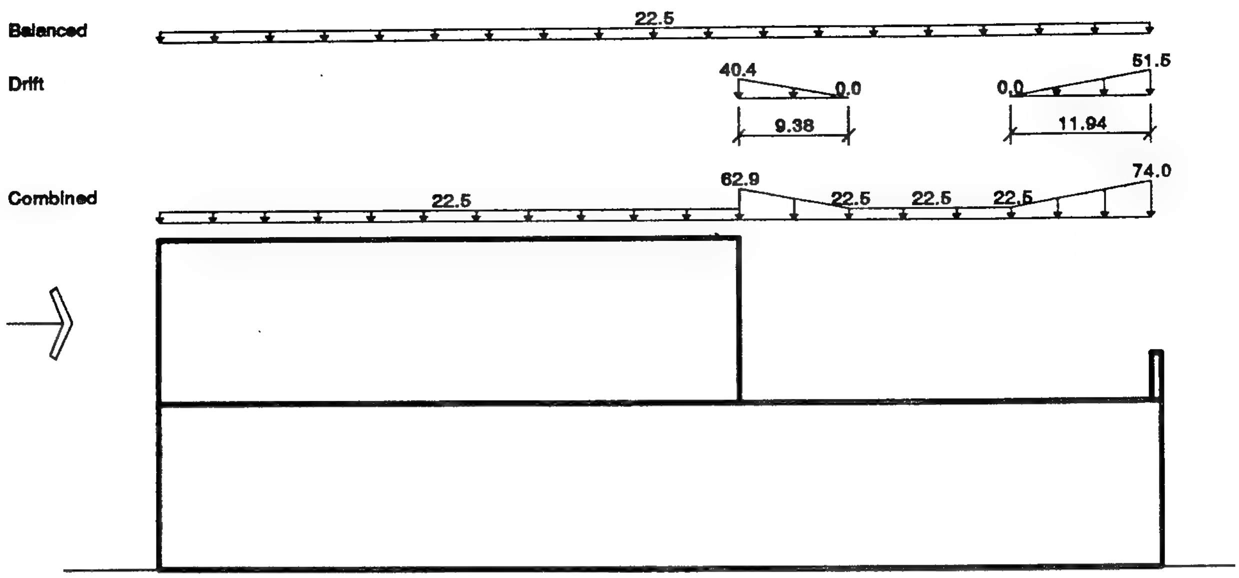

Draw Building Volume
Draw Gable Roof Volume
Unlock N-S & E-W
Draw Parapet Walls
Initial Shape Size
Height: 4'0"
✓ Stack On Plane
Position Vertical Plane On Roof
Initial Shape Size
Orientation: E-W
Position Vertical Planes On Roof
Rotate View To Select Both Slice Planes
Slice Both E-W Vertical Planes
Delete 4 Unwanted Sliced Shapes
Remove Gable Roof Volume
Delete Prism Shape
Check Building Volume
Tape Measure
Plan, Elevation And Section
Zoom And Pan
End



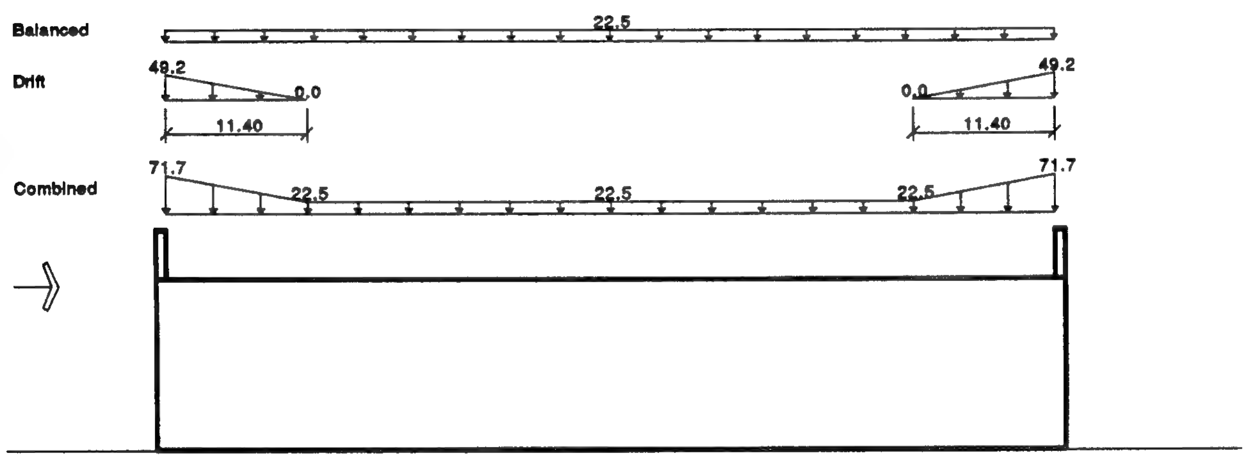
Snow Loads



Start
Use Loads And Design Tool Palette
Calculate Snow Loads
Review Criteria
Calculate
View Output
View Section
Print Screen
Printer
View Calculations
Print Data
Snow
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End



Snow Loads (psf)



Snow Loads (psf)

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  11:39 AM

******************* Flat/Lean-To Roof Snow Load Design ********************

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*Ct*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I  = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Since theta < 0.5 in/ft, 5.0 psf rain-on-snow surcharge applies.
Pf = 22.50 psf
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20.0*I
Min Pf = 20.00 psf
+-------------------------+
|     Pf = 22.50 psf      |
+-------------------------+

Sloped Roof Snow Load (Ps)
Ps = Cs*Pf
Roof Slippery: No
Cs = 1.00
+-------------------------+
|     Ps = 22.50 psf      |
+-------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 84.83 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 3.10 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 12.38 ft
w = 4*hc = 11.94 ft
+-------------------------+
|      W = 11.94 ft       |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 3.10 ft
hd > hc, therefore hd = hc = 2.99 ft
Pd = hd*density
```

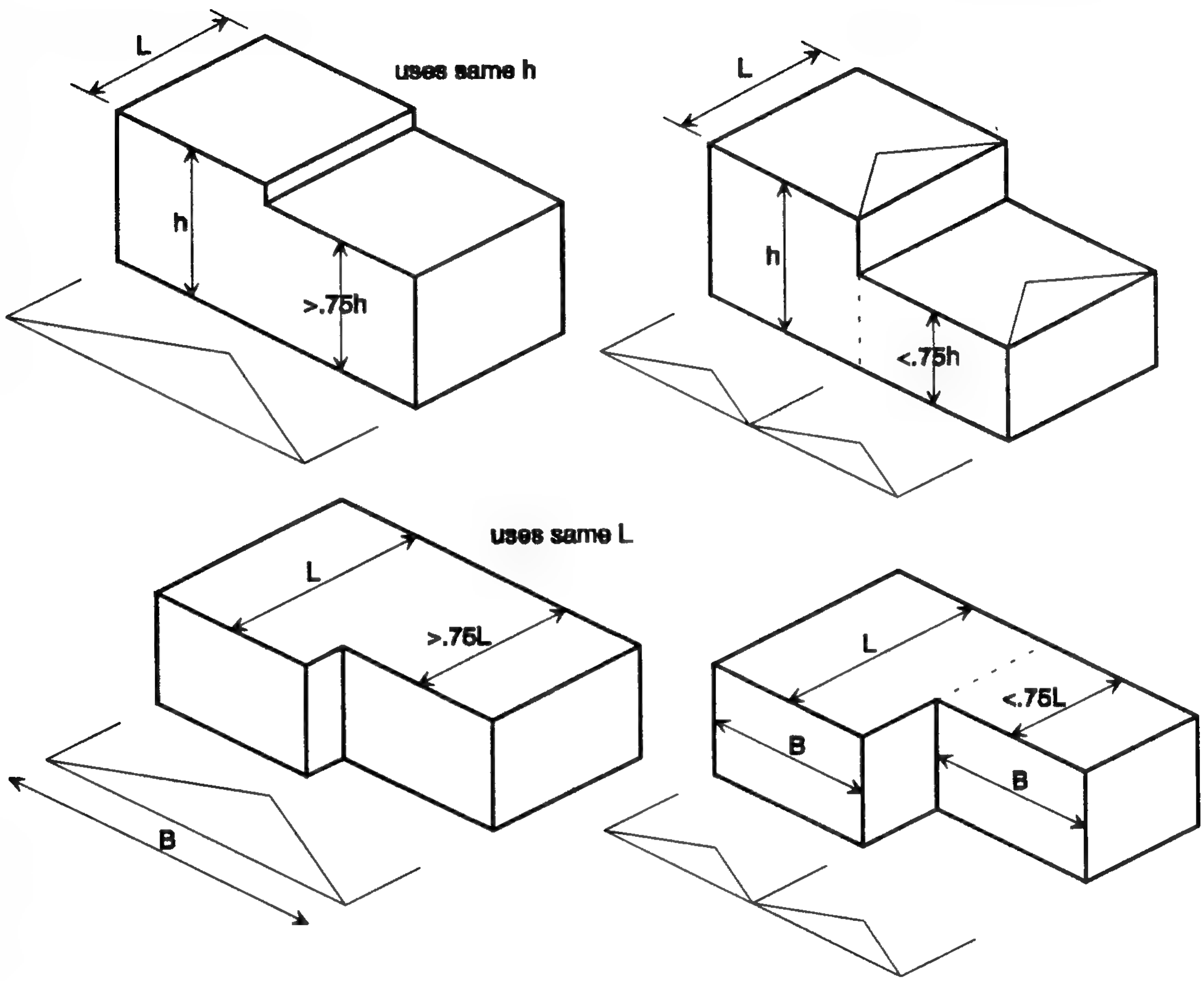
```
+-------------------------+
|     Pd = 51.50 psf      |
+-------------------------+

************************* Drift Snow Load Design **************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 72.00 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.85 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 11.40 ft
w = 4*hc = 11.94 ft
+-------------------------+
|      W = 11.40 ft       |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 2.85 ft
hd <= hc
Pd = hd*density
+-------------------------+
|     Pd = 49.18 psf      |
+-------------------------+

************************* Drift Snow Load Design **************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.99 ft
hc/hb = 12.80 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.34 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft
+-------------------------+
|      W = 9.38 ft        |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 2.34 ft
hd <= hc
```

```
Pd = hd*density
+-------------------------+
|     Pd = 40.44 psf      |
+-------------------------+
```

Wind Assumptions

Proportions For B/L & h/L

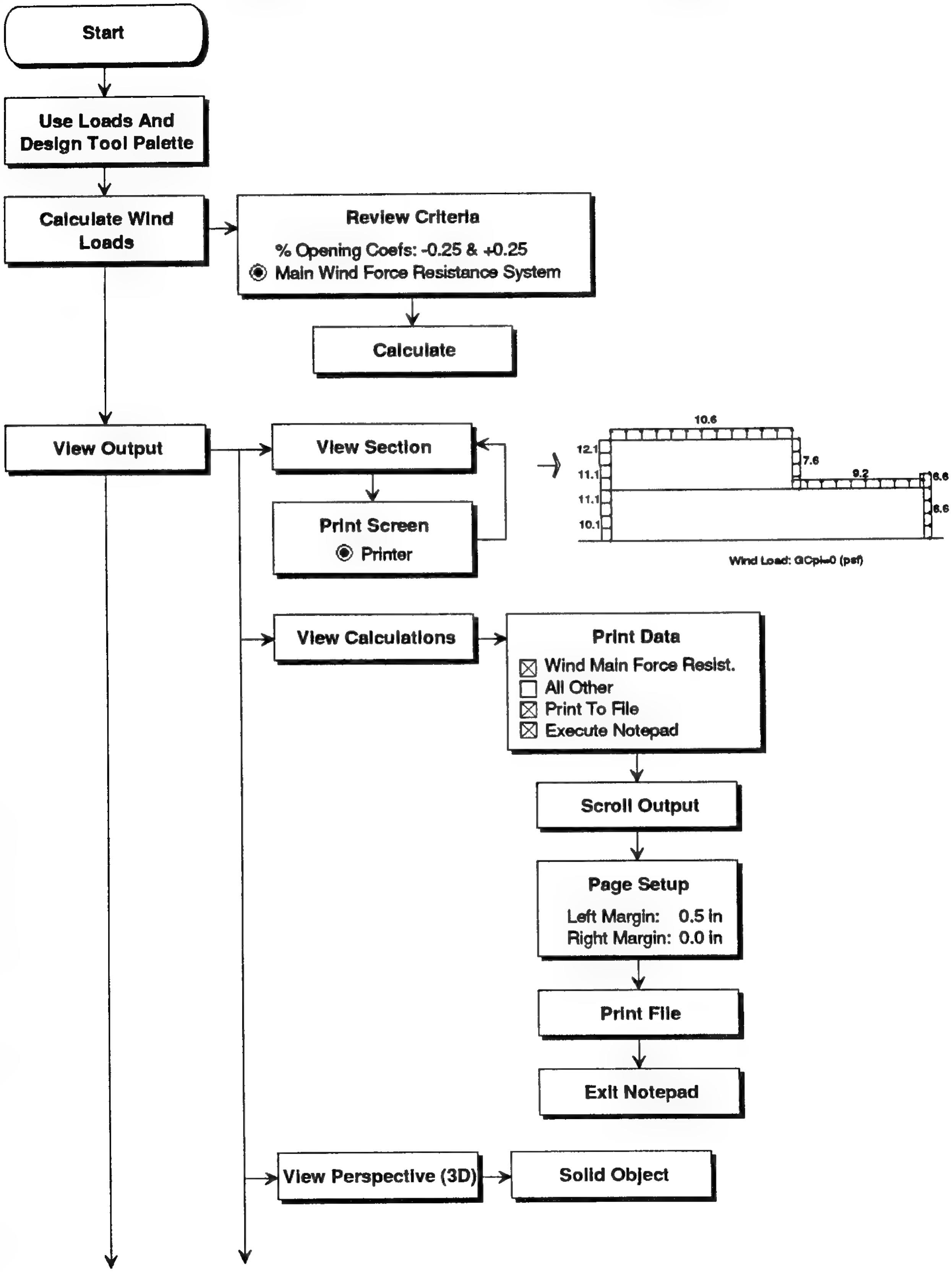
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

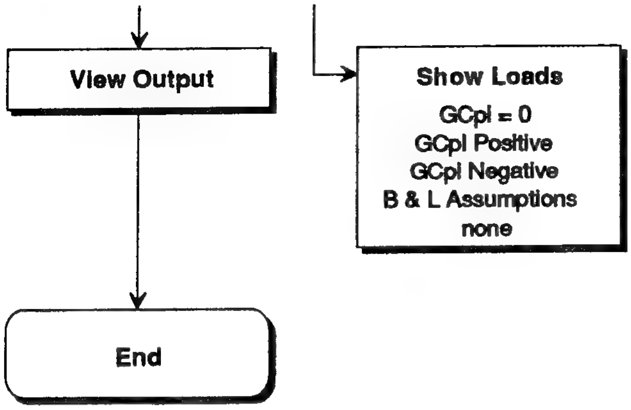


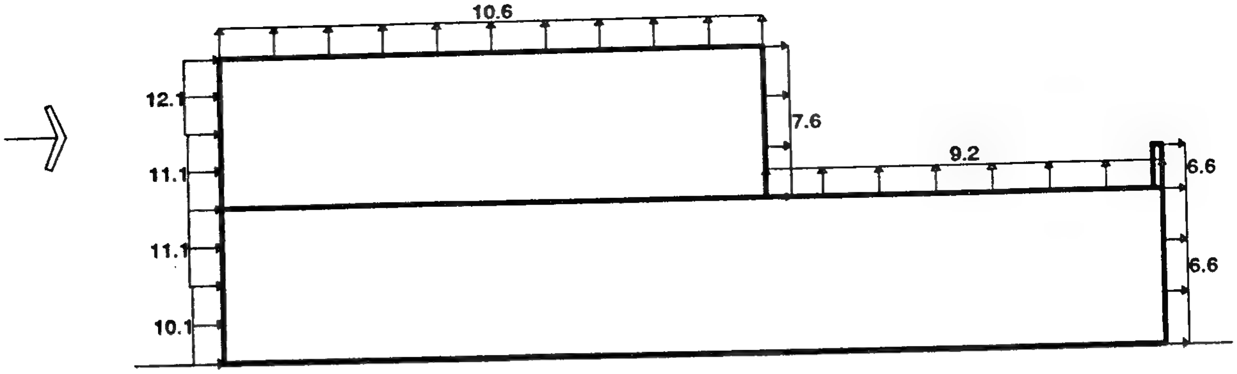
Building Height Maximum 60 Feet

Assumed for components and cladding

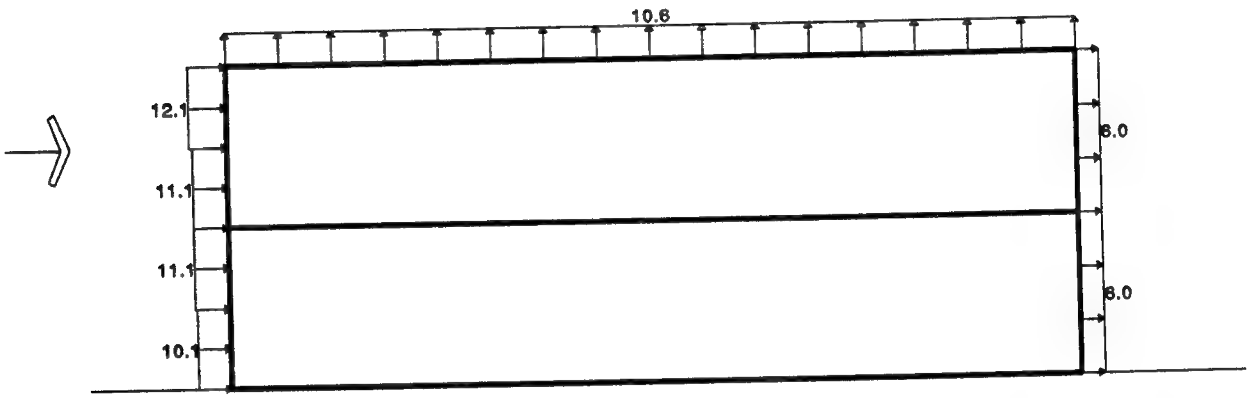
Main Wind Force Resisting Loads



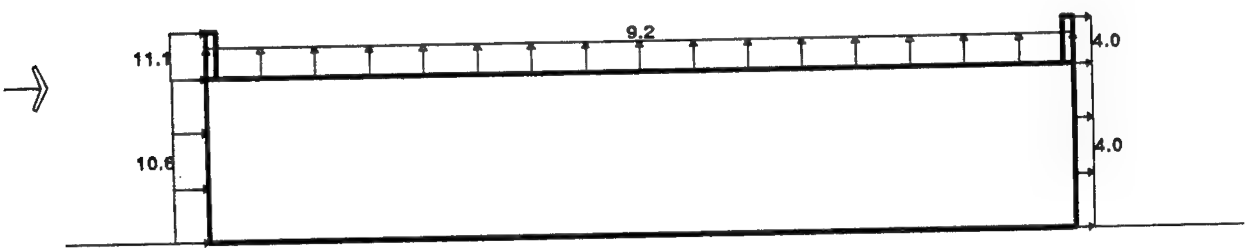

View Output
Show Loads
GCpl = 0
GCpl Positive
GCpl Negative
B & L Assumptions
none
End



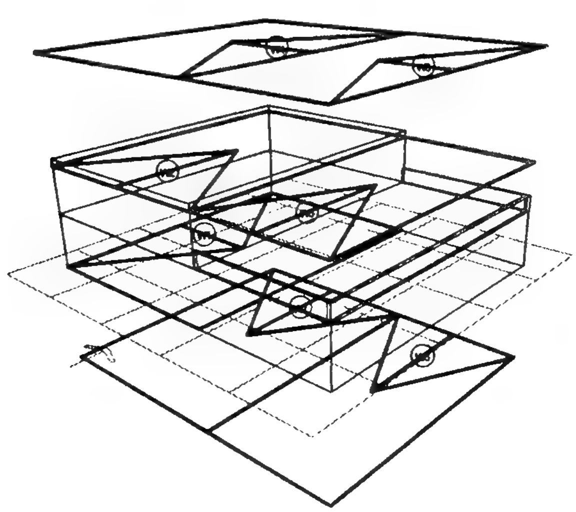
Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Project : Office Building - Scheme B
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Mon Aug 29, 1994 4:13 PM

****************************** Wind Load - 1 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External GCpi=0	Pressure P (psf) -0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

****************************** Wind Load - 2 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External GCpi=0	Pressure P (psf) -0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0	-3.0	-9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

******************************* Wind Load - 3 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	36.0	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.50	-6.6	-4.1	-9.1
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

******************************* Wind Load - 4 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 2	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 1 - 2	14.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

******************************* Wind Load - 5 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	36.0	73.7	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External GCpi=0	Pressure P (psf) -0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.30	-4.0	-1.5	-6.5
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Notes for main framing:

Positive pressures act toward surfaces.

Pressure or suction = P = q*Gh*Cp-qh*(GCpi)

q: qz for windward wall evaluated at height z.

qh for leeward wall, side walls, and roof evaluated at mean roof height.

** For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:

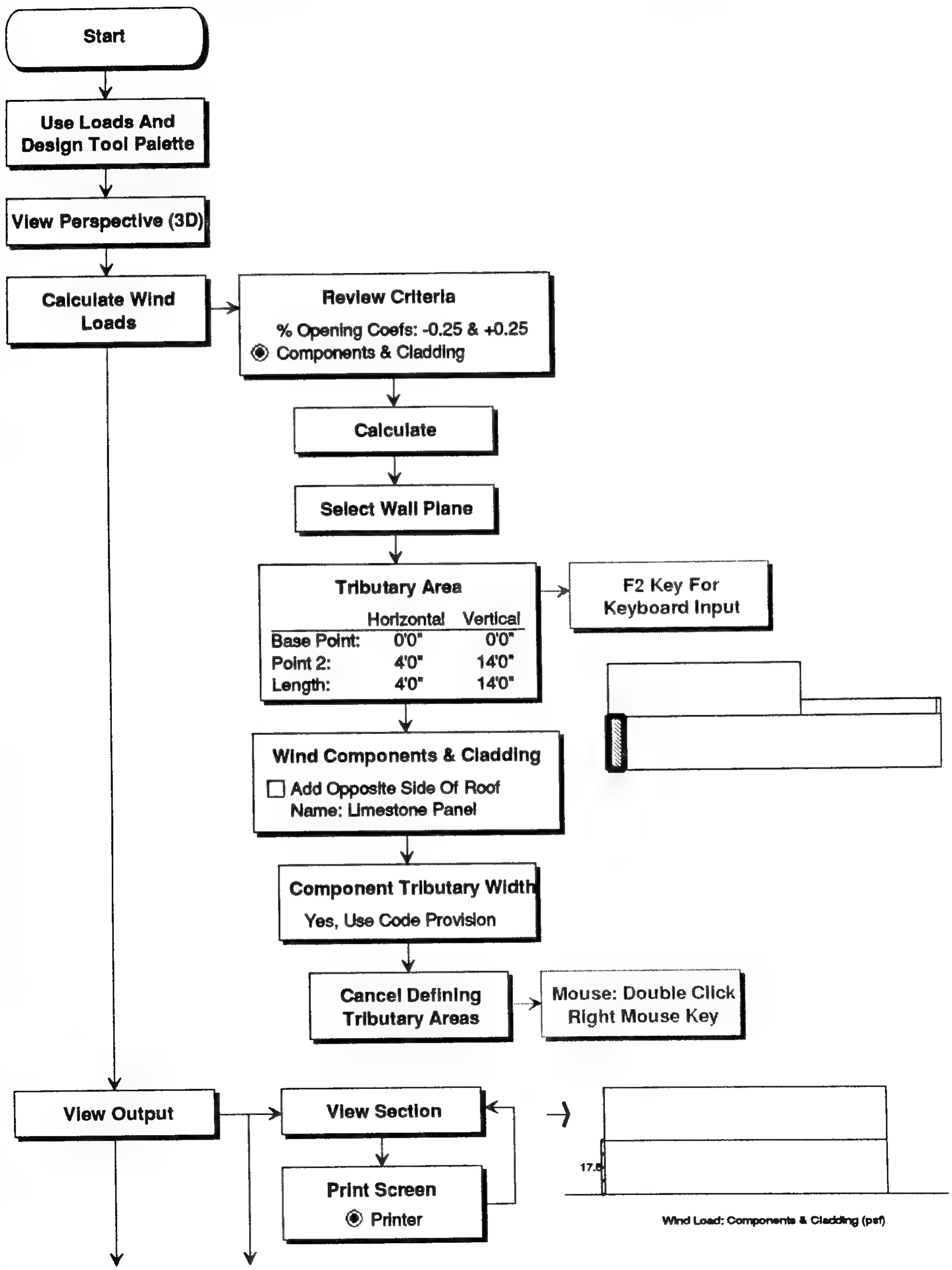
(1) Values are to be used with qz or qh as specified in Table 4.

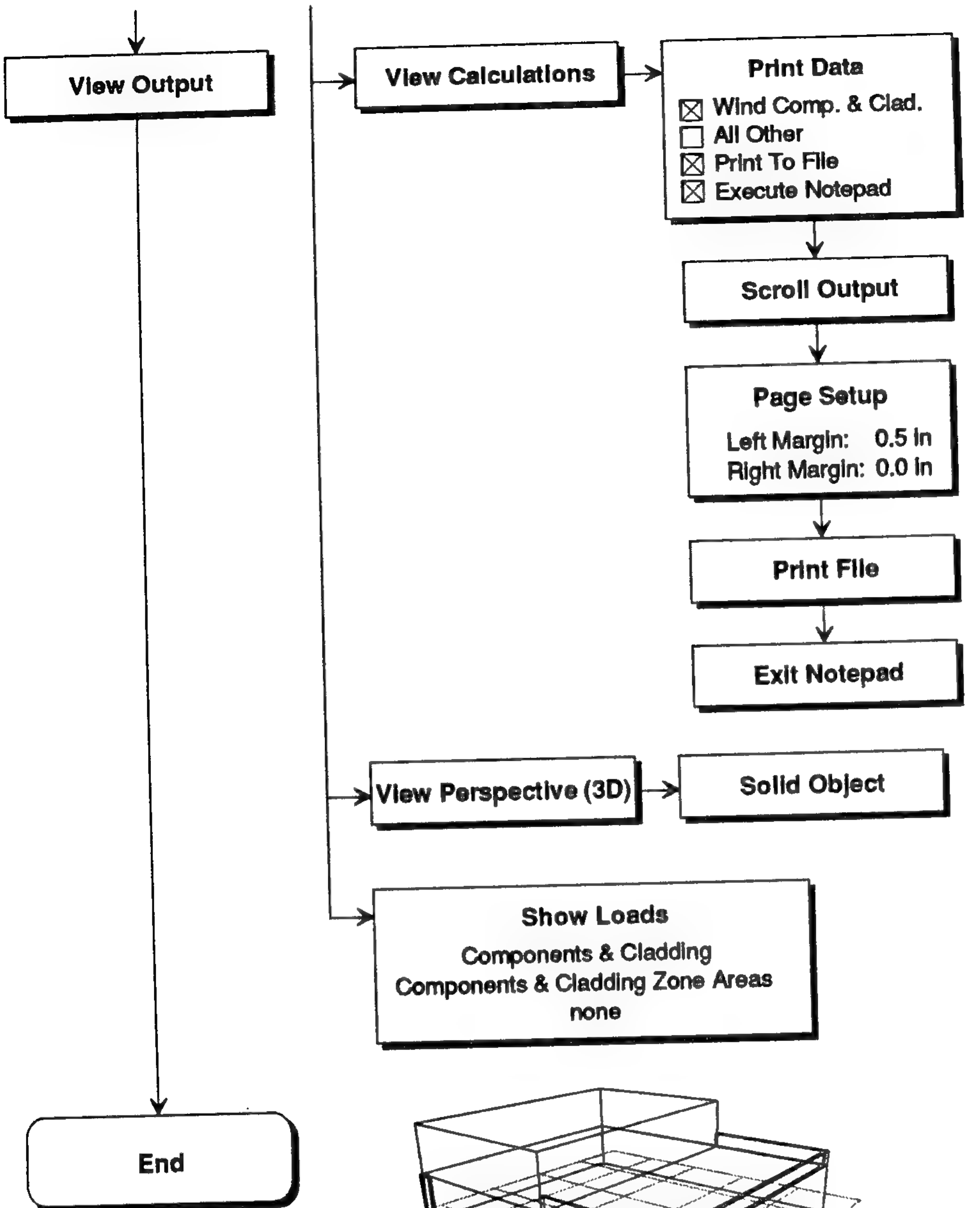
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

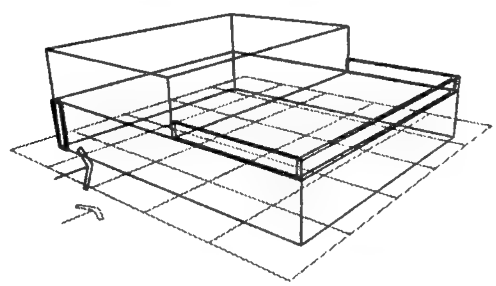
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.

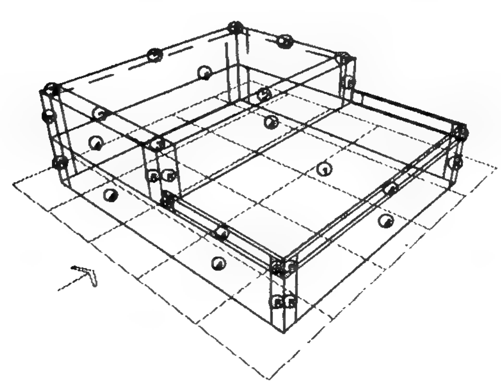
(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

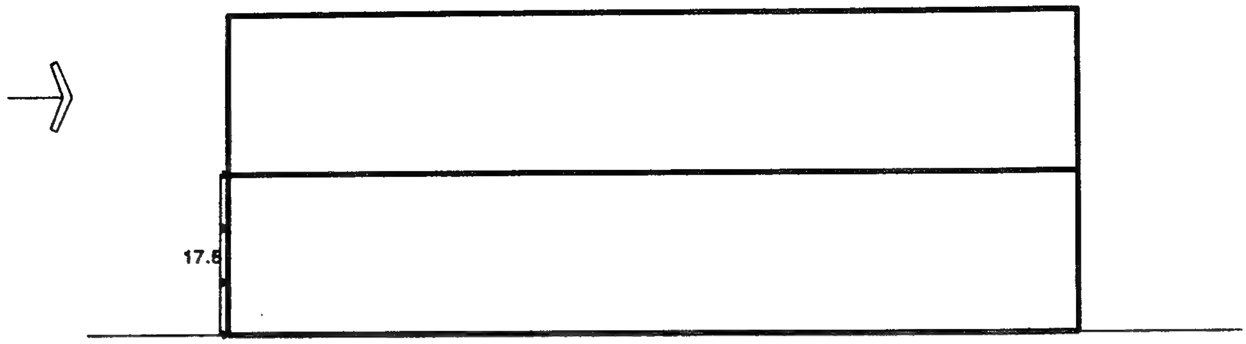
Wind Components & Cladding Loads



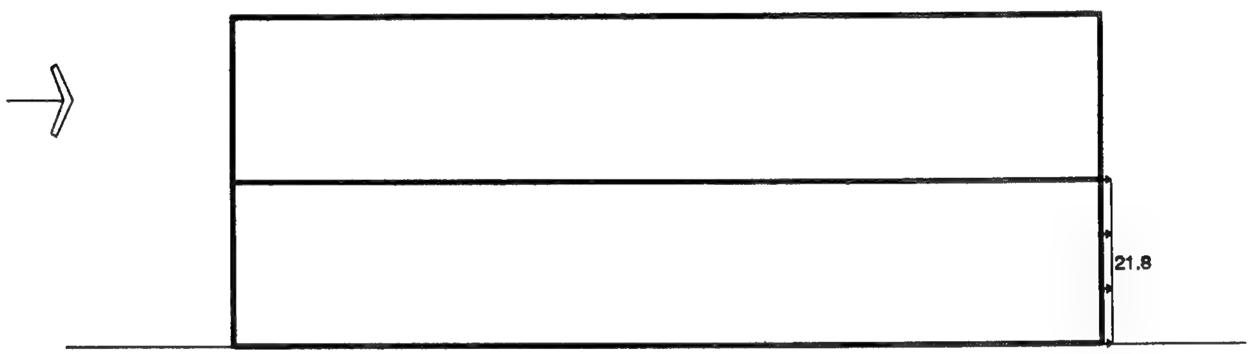

View Output
View Calculations
Print Data
☒ Wind Comp. & Clad.
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
Components & Cladding
Components & Cladding Zone Areas
none
End



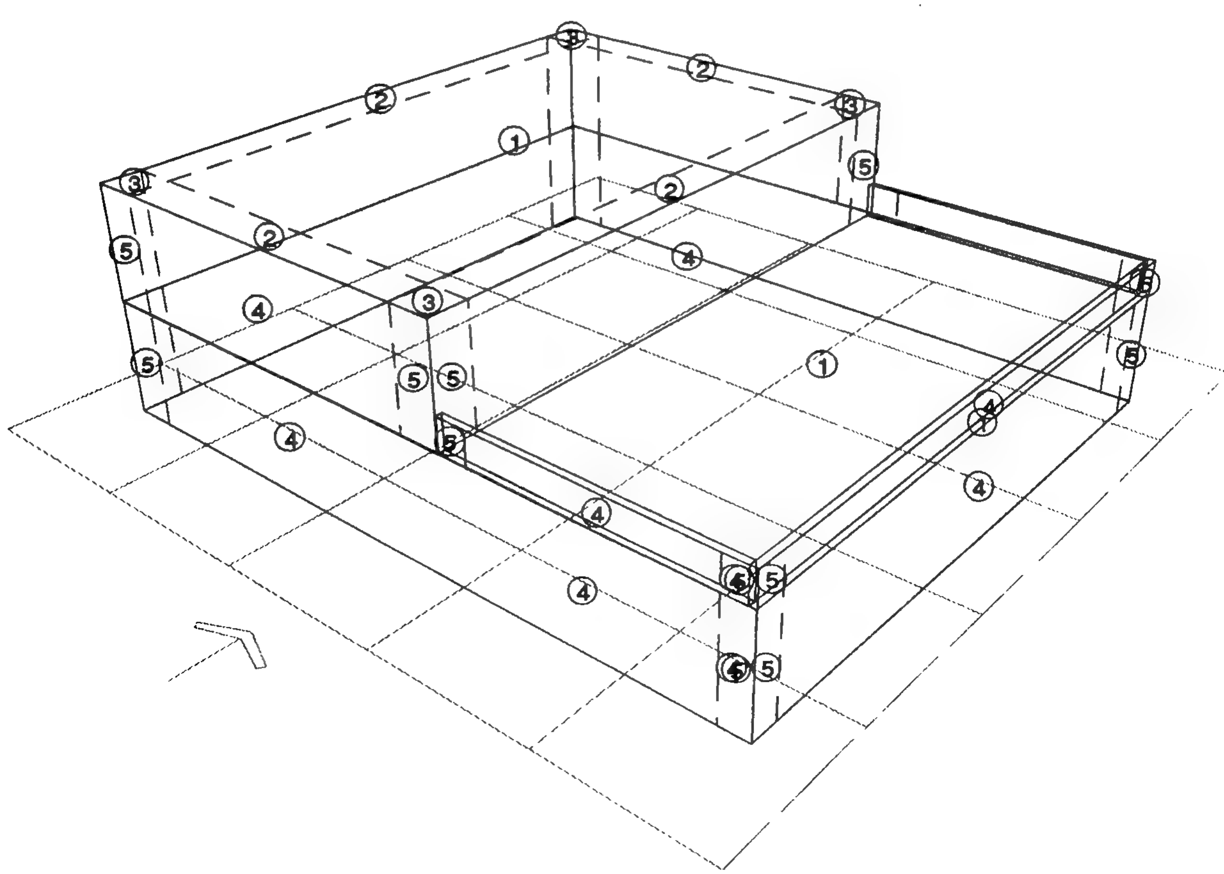




Wind Loads: Components & Cladding (psf)

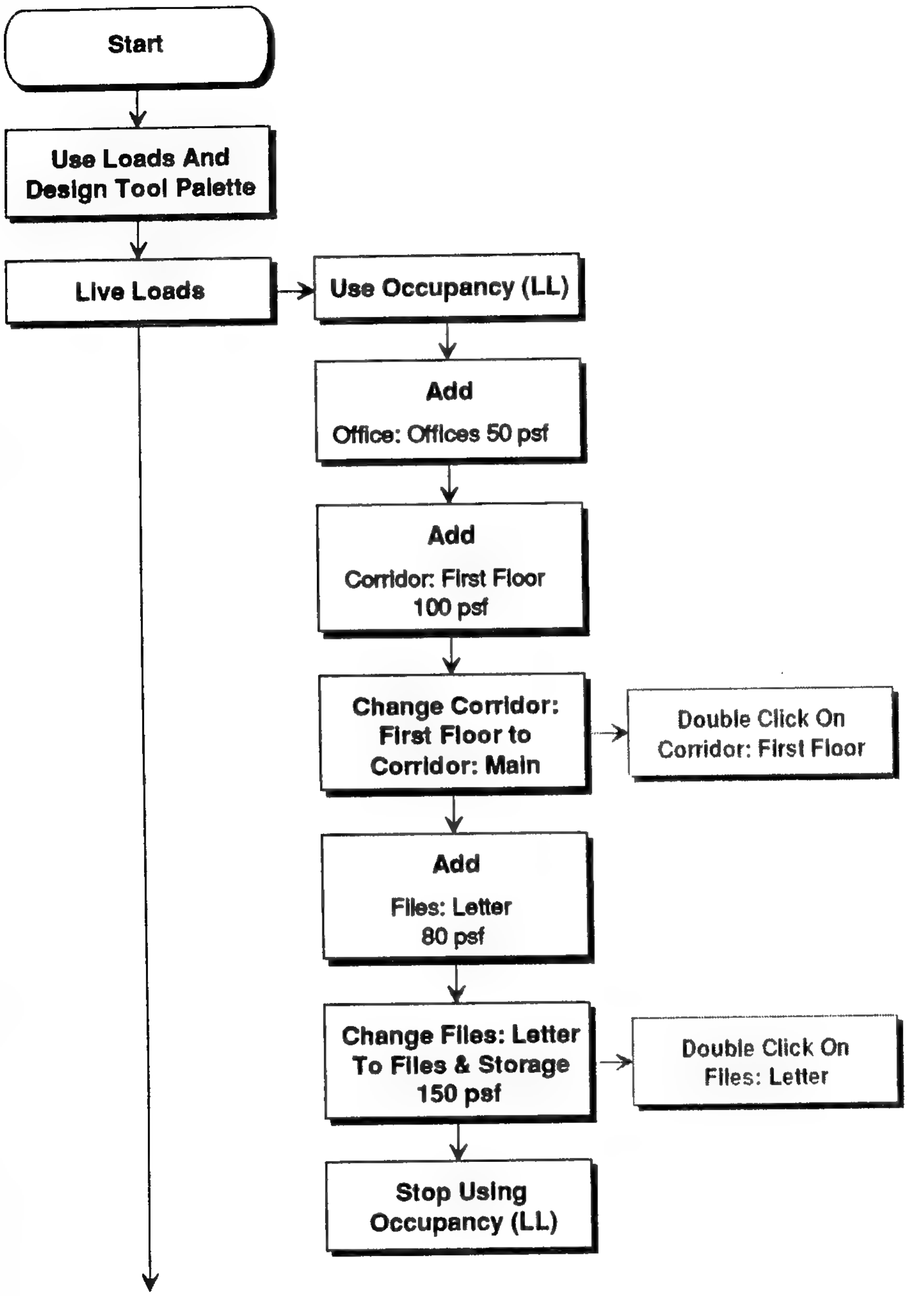


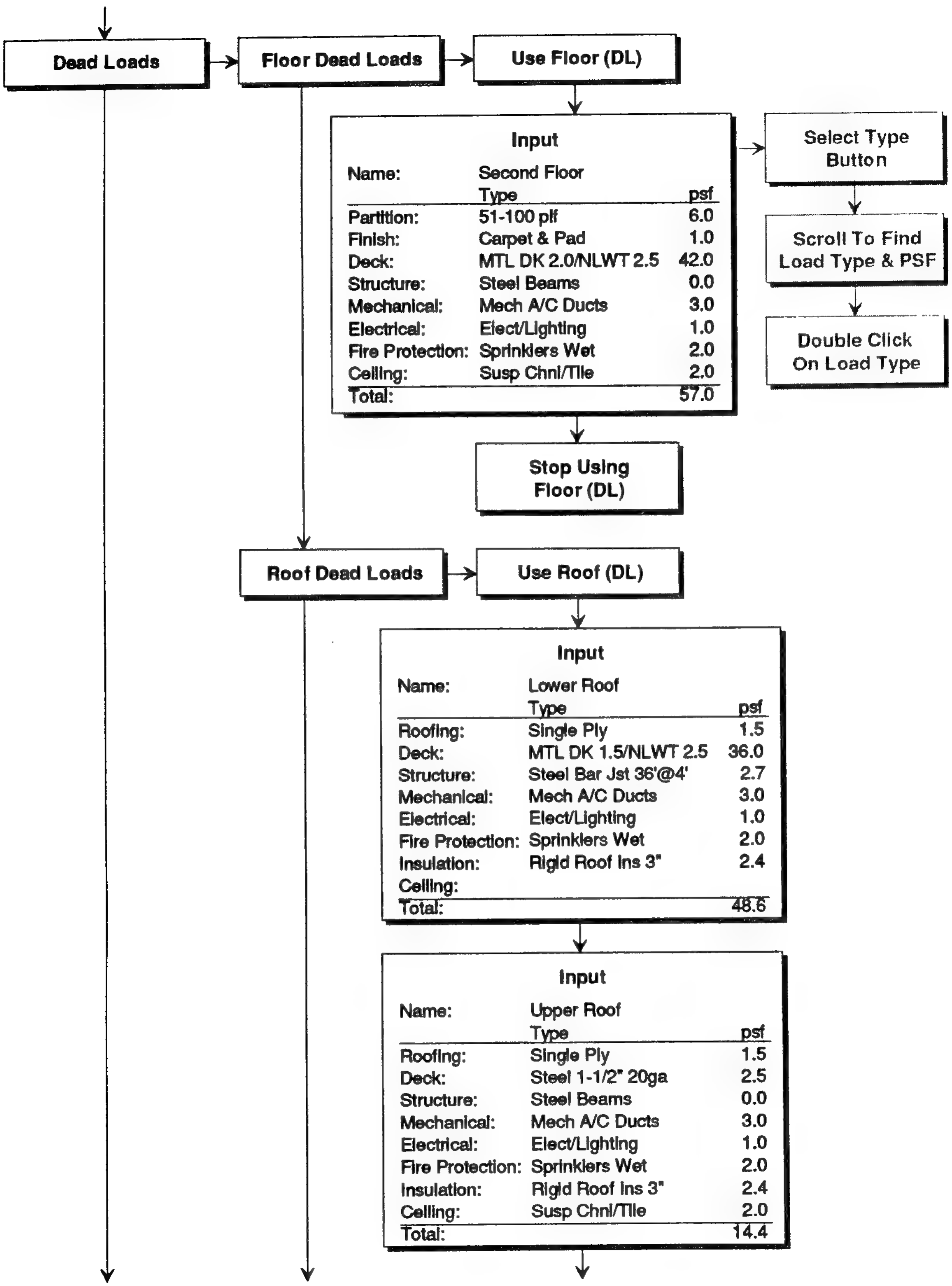
Wind Loads: Components & Cladding (psf)

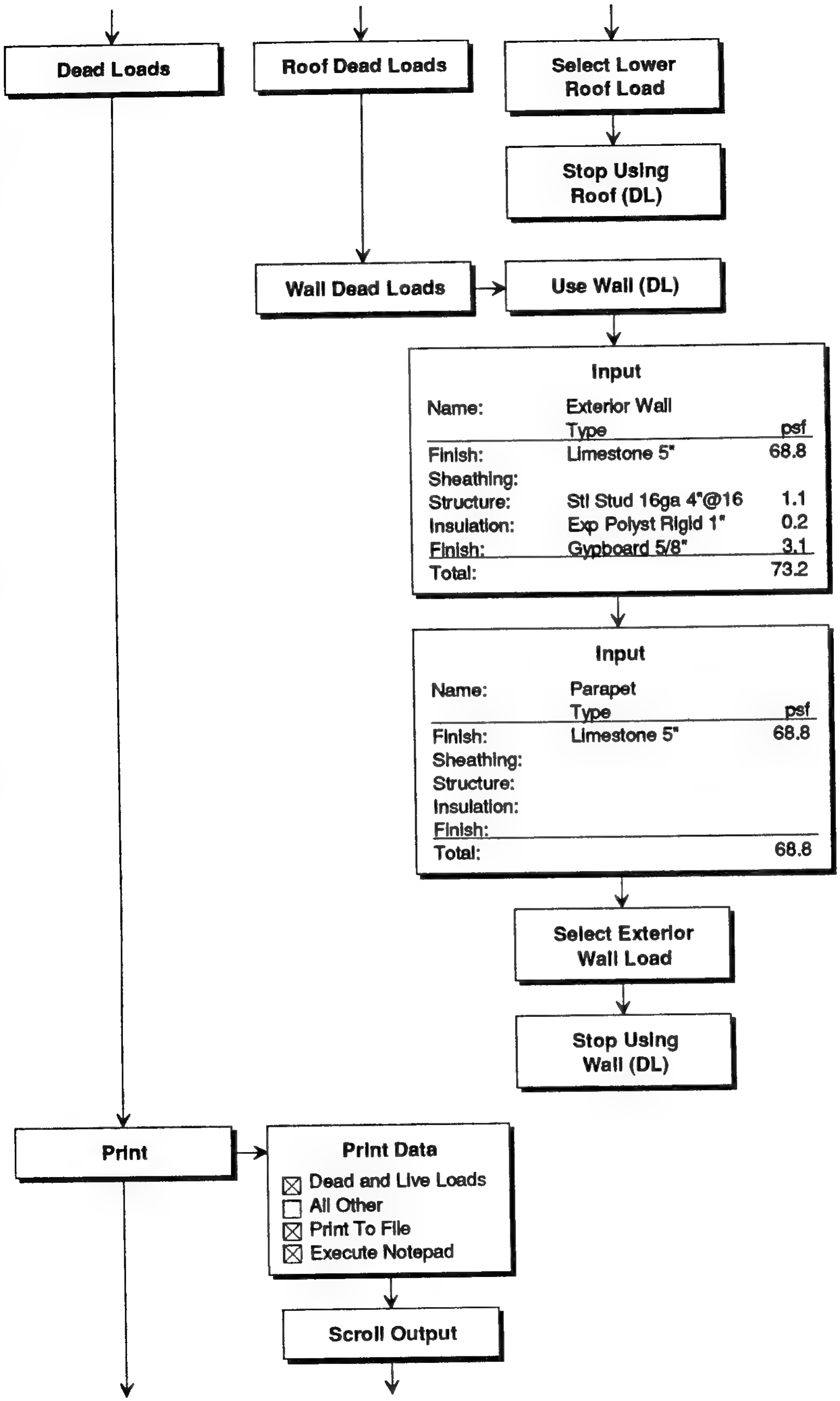


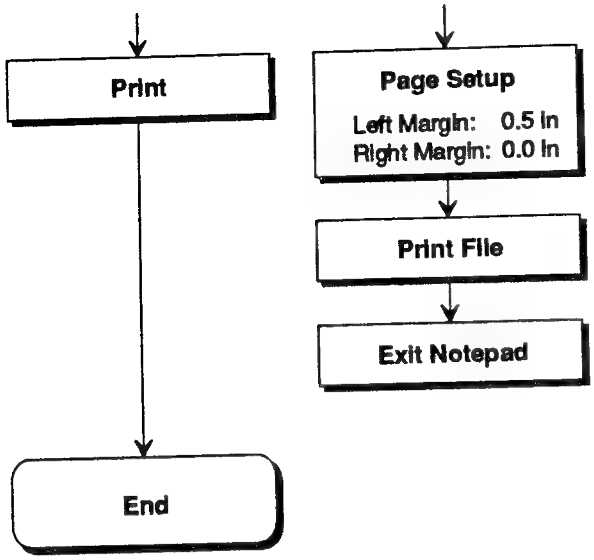
```
Project     : Office Building - Scheme B
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Mon Aug 29, 1994  4:32 PM

******************************** Wind Load ********************************

Velocity  Importance  Exposure   Width     Length            Roof Type
            Factor              Perpend.  Parallel
                                to Wind   to Wind
  (mph)                           (ft)      (ft)
---------------------------------------------------------------------------
  70.0      1.00         C       49.7      73.7

Distance to ocean line >= 100 mi    h/d = 0.56 <= 5

 Height      Kh        qh         GCpi
  (ft)                (psf)
-----------------------------------------
  28.0      0.96      12.0     -0.25  0.25

Height <= 60.0 ft

******************* Component/Cladding Pressures (psf) *******************

           -----------------------------Walls-------------------------------
                   Windward                            Leeward
Tributary   Zone 4           Zone 5          Zone 4           Zone 5
Area (sf)   middles          corners         middles          corners
           GCp      P       GCp      P       GCp      P       GCp      P
           -----------------------------------------------------------------
Internal           -3.0             -3.0              3.0              3.0
Limestone Panel  4.67 ft x 14.00 ft **
  65.3     1.21    17.5     1.21    17.5   -1.31    -18.7   -1.57    -21.8
                                     a = 5.0 ft

Notes for components and cladding:
   P = qh(GCp)-qh(GCpi)
   Internal pressures have been included in above values.
   To comply with TM 5-809-1, wall external pressures
   have not been reduced 10% per ASCE figure 3, note 3.
   ** For a rectangular tributary area, the width of the area
      need not be less than one-third the length of the area.
   Internal Pressure Coefficients for Buildings, GCpi:
                             Condition                                GCpi
   --------------------------------------------------------------------------
   Condition I   All conditions except as noted under condition II.   +0.25
                                                                       -0.25
   Condition II  Buildings in which both of the following are met:    +0.75
                 1. Percentage of openings in one wall exceeds the    -0.25
                    sum of the percentages of openings in the
                    remaining walls and roof surfaces by 5% or
                    more, and
                 2. Percentage of openings in any one of the
                    remaining walls or roof do not exceed 20%.
   --------------------------------------------------------------------------
   Notes:
     (1) Values are to be used with qz or qh as specified in Table 4.
     (2) Plus and minus signs signify pressures acting toward and away from
         the surfaces, respectively.
     (3) To ascertain the critical load requirements for the appropriate
         condition, two cases shall be considered: a positive value of GCpi
         applied simultaneously to all surfaces, and a negative value of
         GCpi applied to all surfaces.
     (4) Percentage of openings in a wall or roof surface is given by ratio
         of area of openings to gross area for the wall or roof surface
         considered.
```

Dead & Live Loads




Dead Loads
Floor Dead Loads
Use Floor (DL)
Input
Name: Second Floor
Type psf
Partition: 51-100 plf 6.0
Finish: Carpet & Pad 1.0
Deck: MTL DK 2.0/NLWT 2.5 42.0
Structure: Steel Beams 0.0
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Ceiling: Susp Chnl/Tile 2.0
Total: 57.0
Select Type Button
Scroll To Find Load Type & PSF
Double Click On Load Type
Stop Using Floor (DL)
Roof Dead Loads
Use Roof (DL)
Input
Name: Lower Roof
Type psf
Roofing: Single Ply 1.5
Deck: MTL DK 1.5/NLWT 2.5 36.0
Structure: Steel Bar Jst 36'@4' 2.7
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling:
Total: 48.6
Input
Name: Upper Roof
Type psf
Roofing: Single Ply 1.5
Deck: Steel 1-1/2" 20ga 2.5
Structure: Steel Beams 0.0
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling: Susp Chnl/Tile 2.0
Total: 14.4


Dead Loads
Roof Dead Loads
Select Lower Roof Load
Stop Using Roof (DL)
Wall Dead Loads
Use Wall (DL)
Input
Name: Exterior Wall
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure: Stl Stud 16ga 4"@16 1.1
Insulation: Exp Polyst Rigid 1" 0.2
Finish: Gypboard 5/8" 3.1
Total: 73.2
Input
Name: Parapet
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8
Select Exterior Wall Load
Stop Using Wall (DL)
Print
Print Data
☒ Dead and Live Loads
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output


Print
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Loads

Floor Dead Loads

Name : Second Floor

	Type	psf
Partition	: 51-100 plf	6.0
Finish	: Carpet & Pad	1.0
Deck	: MTL DK 2.0/NLWT 2.5	42.0
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Ceiling	: Susp Chnl/Tile	2.0
Total	:	57.0

Roof Dead Loads

Name : Lower Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: MTL DK 1.5/NLWT 2.5	36.0
Structure	: Steel Bar Jst 36'@4'	2.7
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	:	0.0
Total	:	48.6

Name : Upper Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: Steel 1-1/2" 20ga	2.5
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	: Susp Chnl/Tile	2.0
Total	:	14.4

Wall Dead Loads

Name : Exterior Wall

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	: Stl Stud 16ga 4"@16	1.1
Insulation	: Exp Polysty Rigid 1"	0.2
Finish	: Gypboard 5/8"	3.1
Total	:	73.2

Name : Parapet

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	:	0.0
Insulation	:	0.0
Finish	:	0.0
Total	:	68.8

Occupancy Live Loads

Name	psf
Office: Offices	50
Corridor: Main	100
Files & Storage	150 a

a. These design loads are extremely variable. The design load will be increased when data is available.

Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400.0 sqft or more may be reduced with: L = Lo*[0.25+(15/sqrt(Ai))]

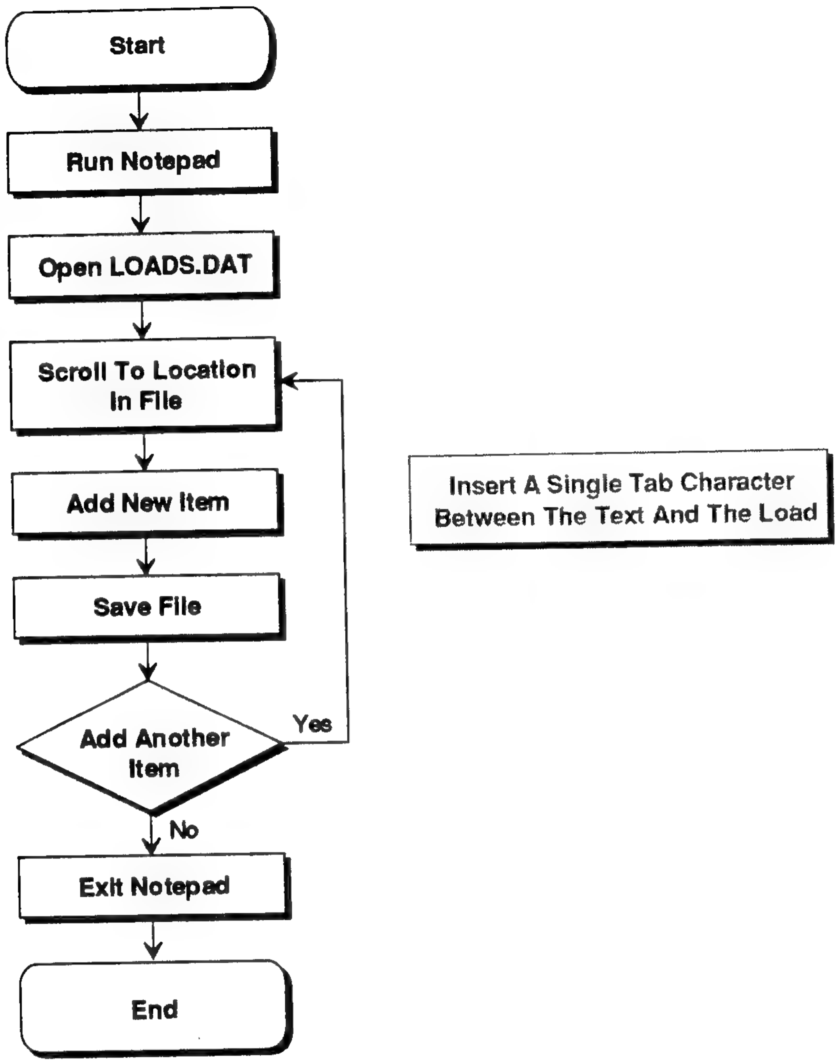
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.

Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- -public assembly
- -garages [except where 2 or more floors are supported]
- -one-way slab floor

For live loads greater than 100 psf and for garages used for passenger cars only, no reduction is permitted for members supporting one floor; however, where two or more floors are supported, a 20% reduction is permitted.

Loads Database



Draw Grid & Openings

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/ Lower Roof Horizontal Structural Plane

Structural Plane Information

Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid

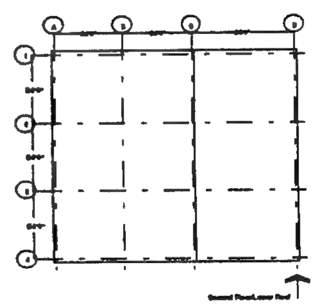
N-S Spacing: 24'0"
E-W Spacing: 24'0"
Perimeter Offset: 10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines



Draw Openings

Add Opening

	Horizontal	Vertical
Base Point:	10"	24'10"
Point 2:	8'10"	48'10"
Length:	8'0"	24'0"

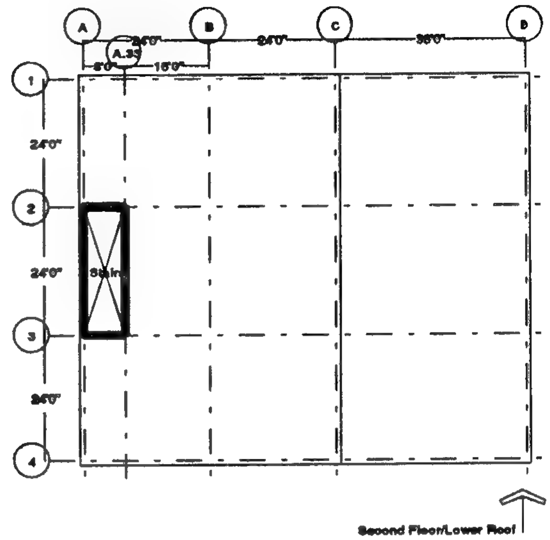
F2 Key For Keyboard Input

Opening

Name: Stairs

☐ Continuous

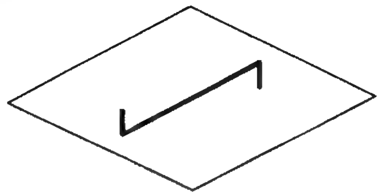
End



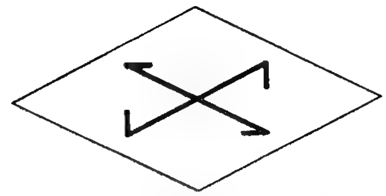
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



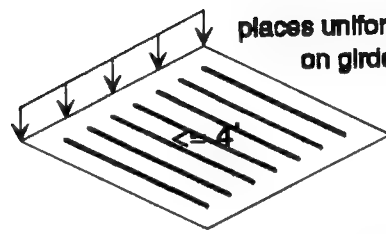
1 way



2 way
(not activated)

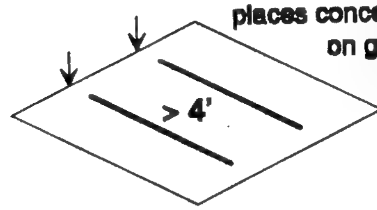
Linear
(horizontal)

Narrowly Spaced
(joists)



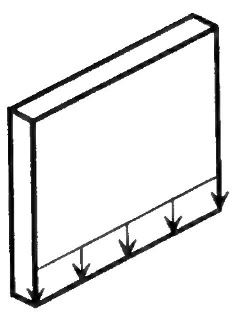
places uniform loads
on girders

Widely Spaced
(beams)



places concentrated loads
on girders

Surface
(vertical)
(planar)

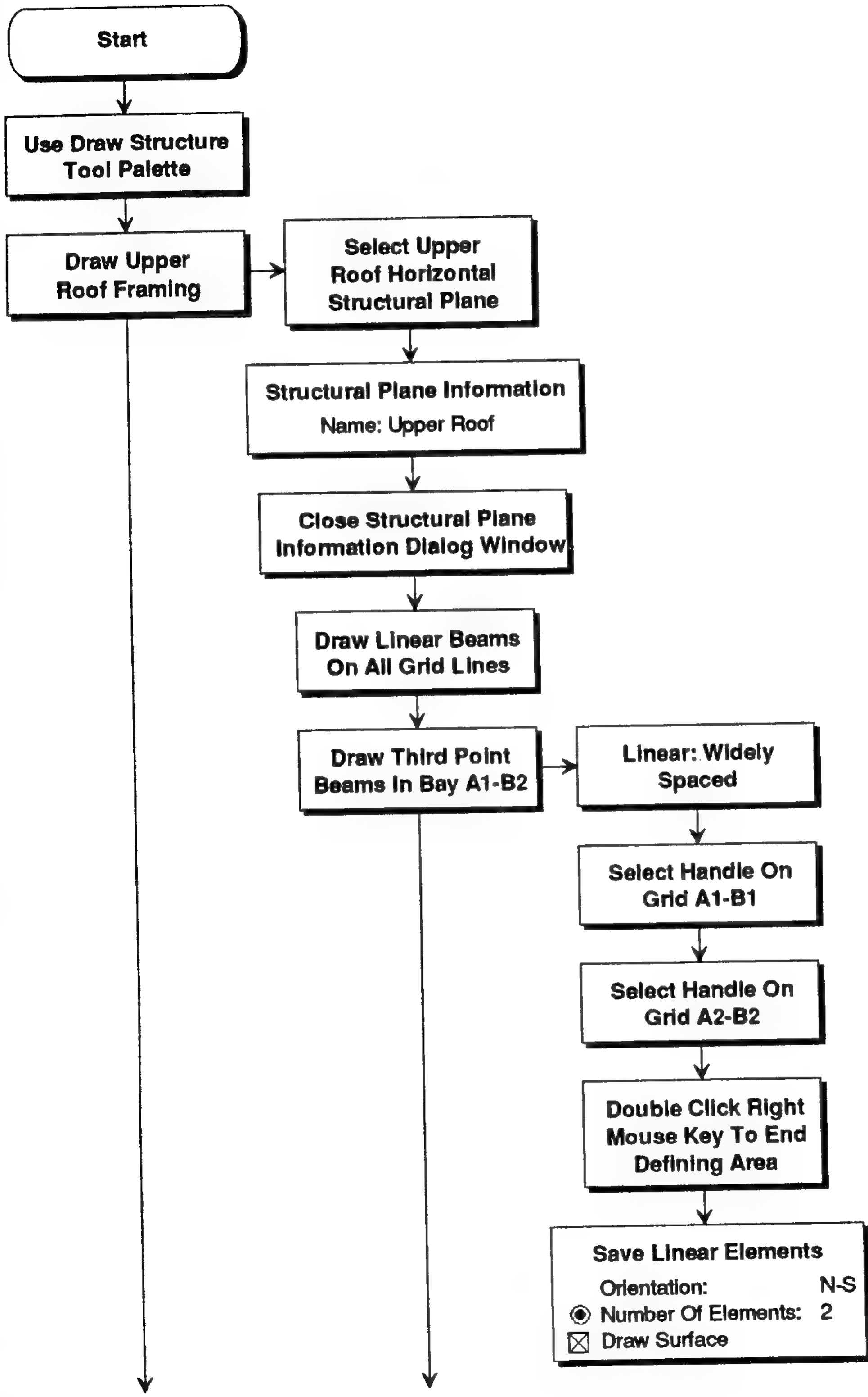


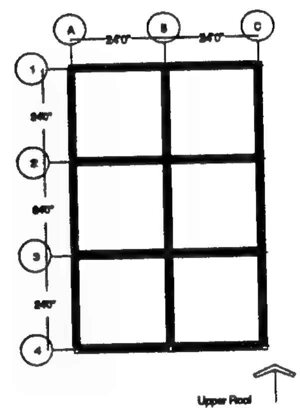
uniform loads

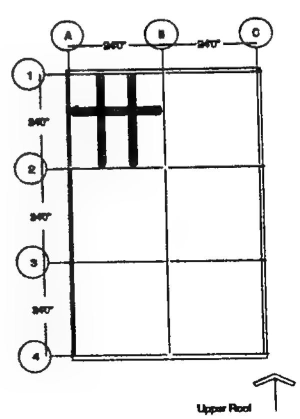
Linear
(vertical)

concentrated loads

Draw Structure







Draw Upper Roof framing

Copy Beams & One-Way Surface To Other Bays

Copy Structure

Select Third Point Beams

Select One-Way Surface

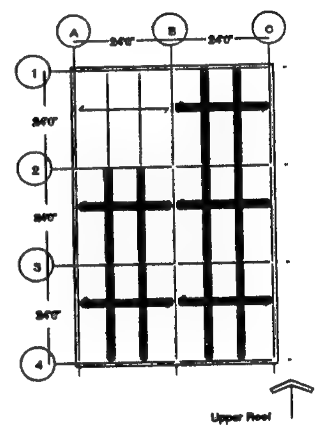
Double Click Right Mouse Key To End Selecting Structure

Select Grid Location A1 As The Base Point

Paste Structure

Select Grid Locations B1, A2, B2, A3, B3

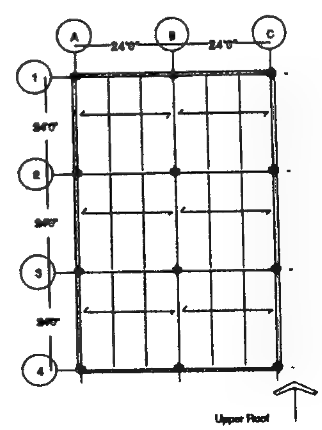
Double Click Right Mouse Key To End



Draw Columns

Column All Grid Intersections

Save Column Elements
Orientation: N-S
☒ All Floors



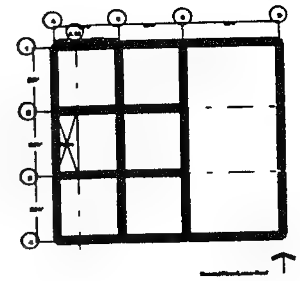
Draw Second Floor/ Lower Roof Framing

Select Second Floor/ Lower Roof Horizontal Structural Plane

Draw Linear Beams On All Grid Lines

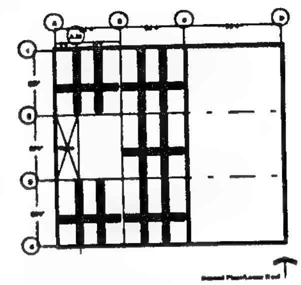
Draw Second Floor/ Lower Roof Framing

Delete Beams At Grid Locations Inside C1-D4



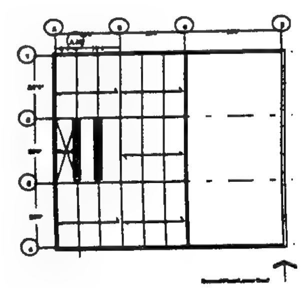
Draw Third Point Beams And One-Way Surface In Bays A1-B2, B1-C2, B2-C3, A3-B4, B3-C4

- **Paste Structure**
- **Select Grid Locations A1, B1, B2, A3, B3**
- **Double Click Right Mouse Key To End**



Draw Third Point Beams In Bay A2-B3

- **Linear: Widely Spaced**
- **Select Handle On Grid B2-B3**
- **Select Handle On Grid A2-A3**
- **Double Click Right Mouse Key To End Defining Area**
- **Save Linear Elements**
  - Orientation: N-S
  - (◉) Number Of Elements: 2
  - ☐ Draw Surface



Draw Surface In Bay A.33,2-B3

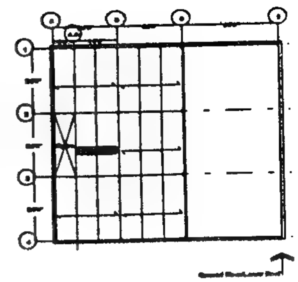
- **Surface: One-Way**
- **Select Handle On Grid A.33,2-A.33,3**
- **Select Handle On Grid Line B2-B3**

Draw Second Floor/ Lower Roof Framing

Draw Surface In Bay A.33,2-B3

Double Click Right Mouse Key To End Defining Area

Save Surface Element
Orientation: E-W



Draw Joists In Bay C1-D4

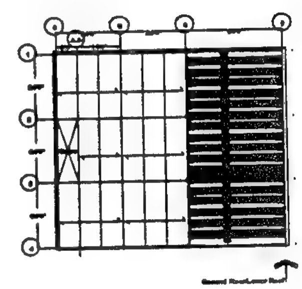
Linear: Narrowly Spaced

Select Handle On Grid C1-D1

Select Handle On Grid C4-D4

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: N-S
◉ Spacing: 48"
☒ Draw Surface



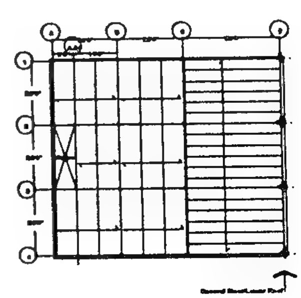
Draw Columns

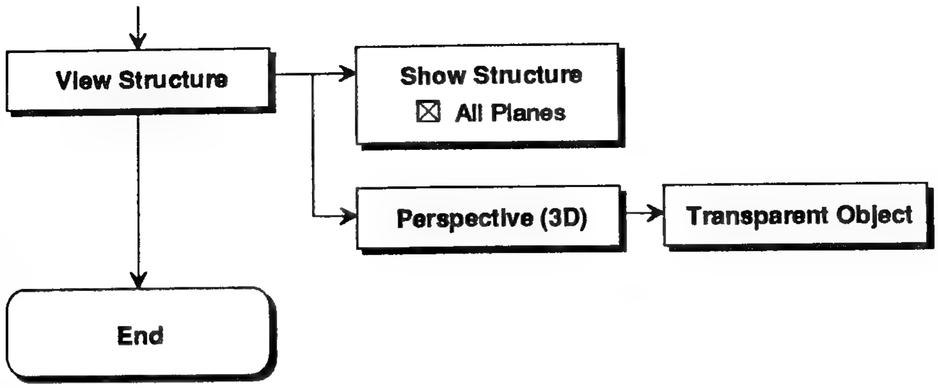
Column One Grid Intersection

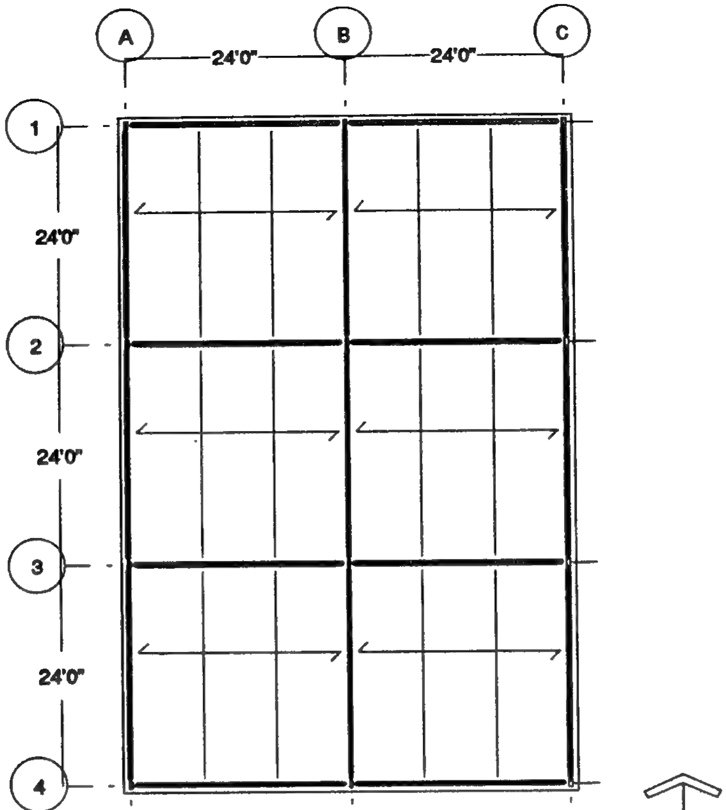
Select Grid Locations D1, D2, D3, D4

Double Click Right Mouse Key To End Selecting Locations

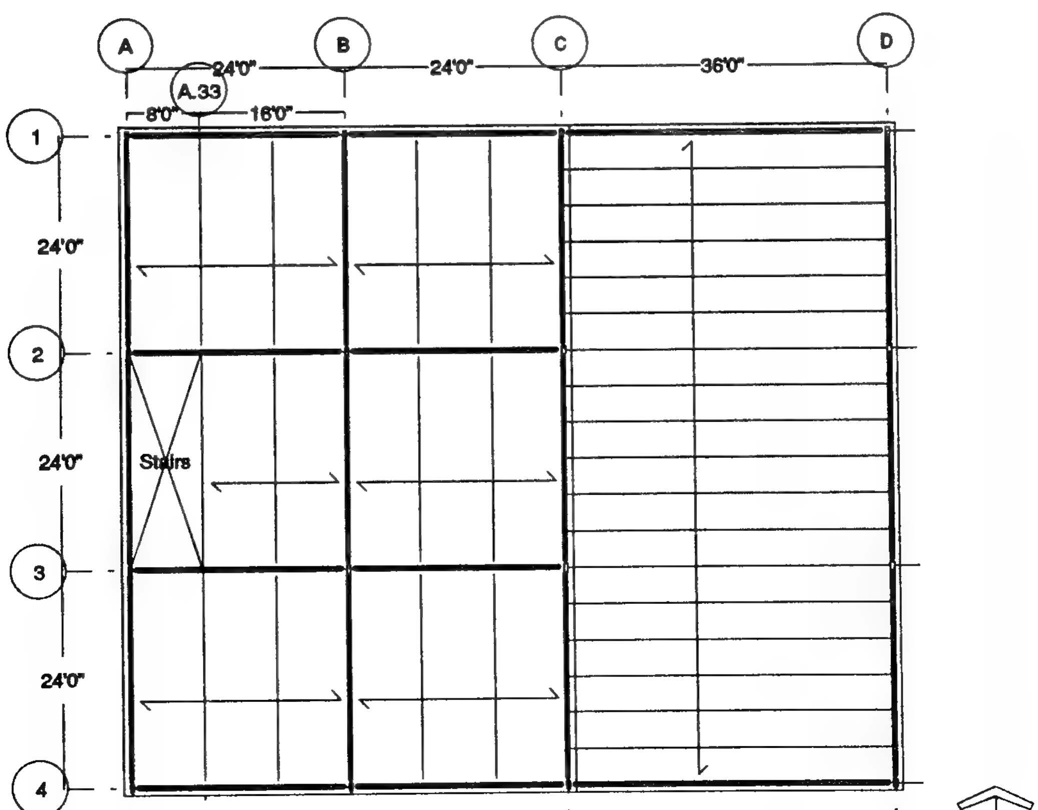
Save Columns
Orientation: N-S
Height: 14'
☐ All Floors



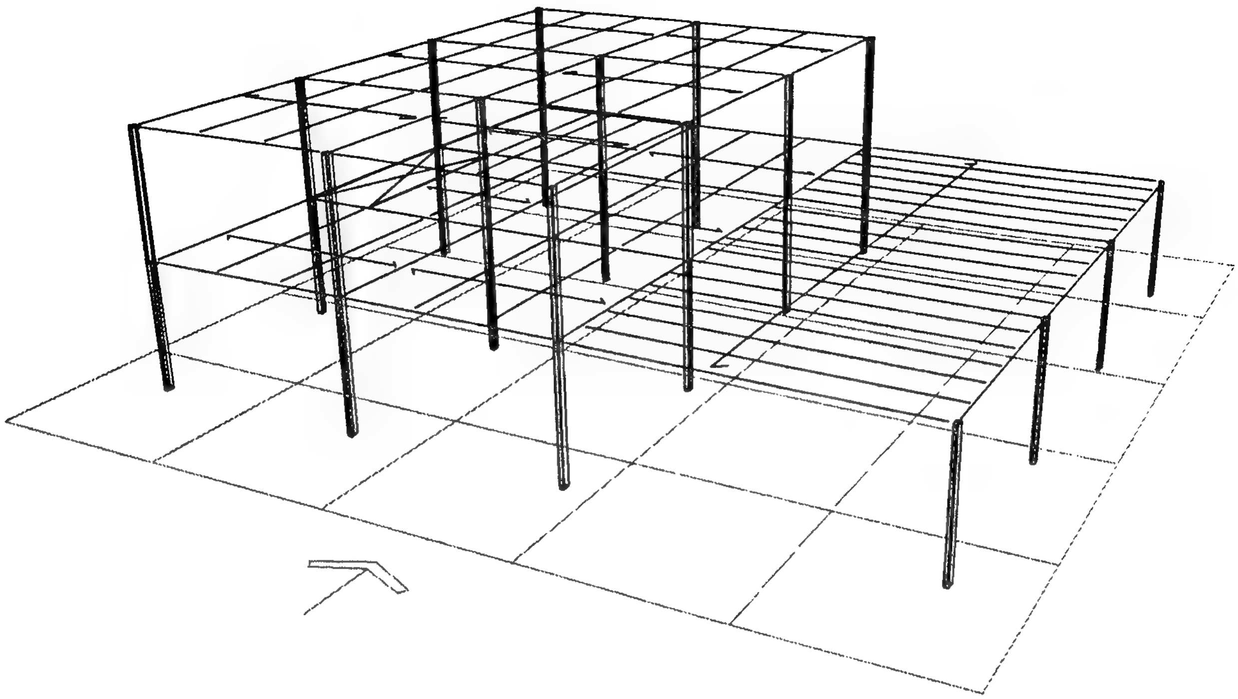

View Structure
Show Structure
☒ All Planes
Perspective (3D)
Transparent Object
End



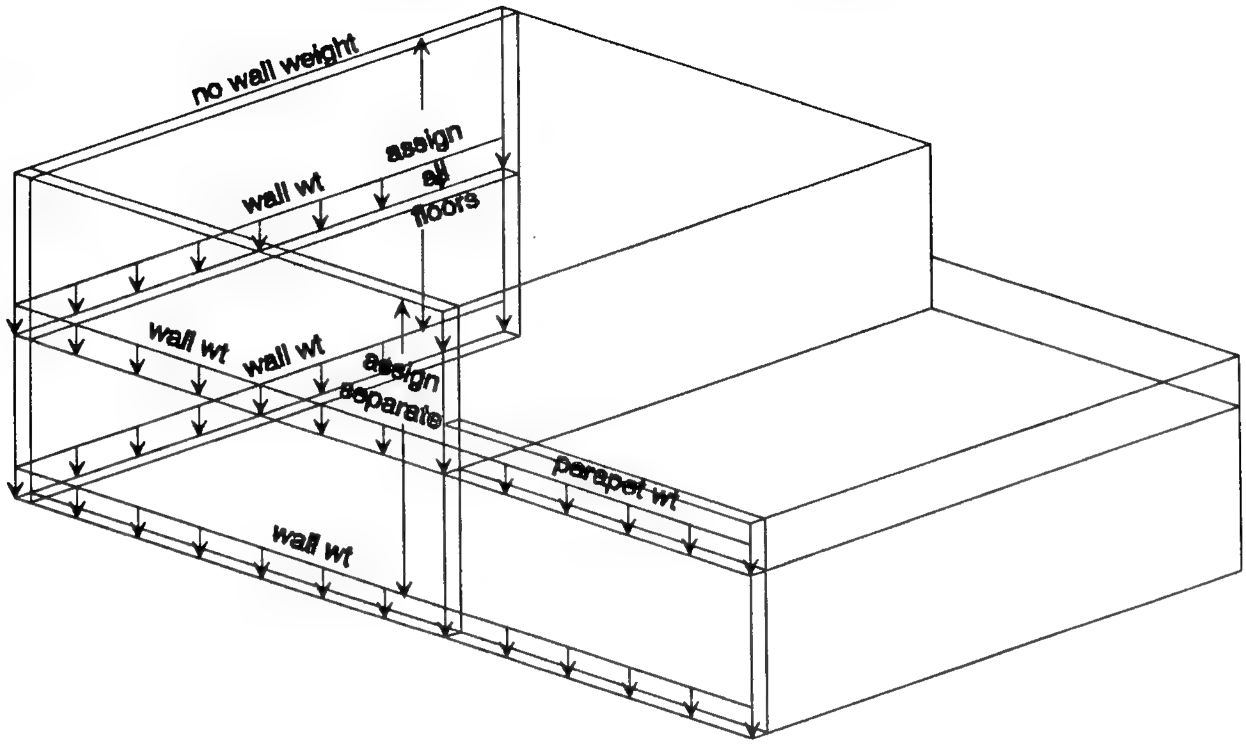
Upper Roof

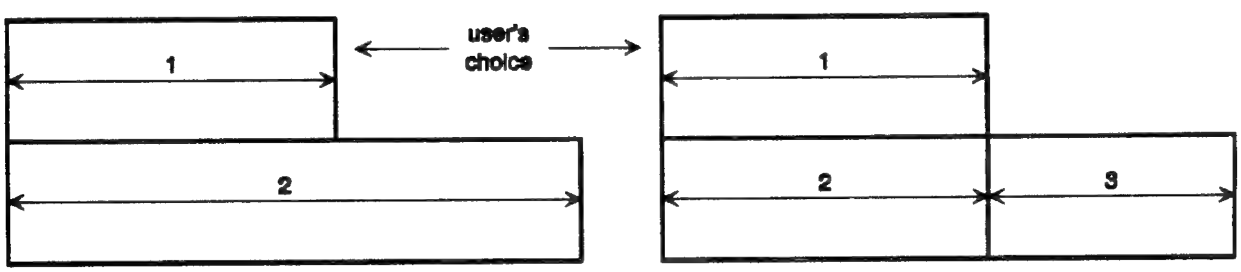


Second Floor/Lower Roof



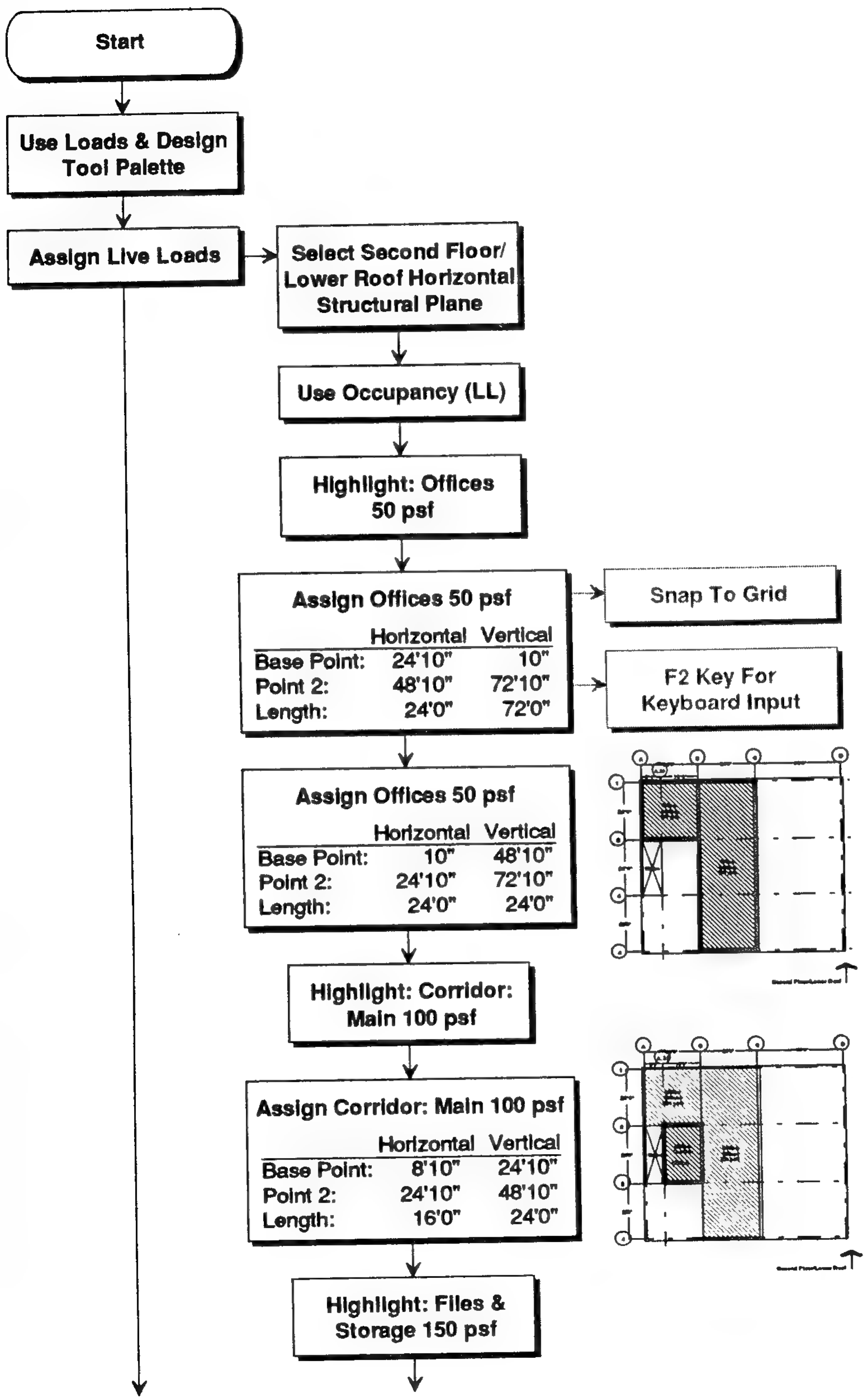
Assign Wall Loads Philosophy





this appproach saves memory

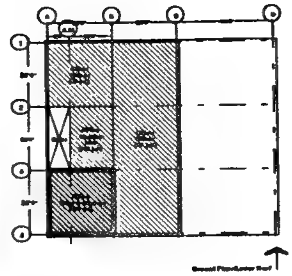
Assign Loads



Assign Live Loads

Assign Files & Storage 150 psf

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	24'10"
Length:	24'0"	24'0"



Stop Using Occupancy (LL)

Assign Dead Loads

Assign Floor Loads

Use Floor (DL)

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	24'10"
Length:	48'0"	24'0"

Assign Second Floor Load

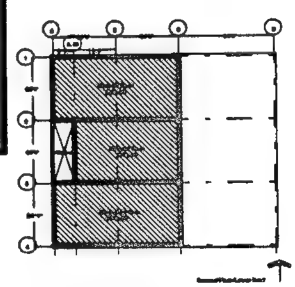
☐ Assign All Floors

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	48'10"	48'10"
Length:	40'0"	24'0"

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	48'10"	72'10"
Length:	48'0"	24'0"



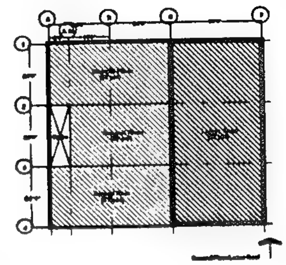
Stop Using Floor (DL)

Assign Dead Loads

Assign Roof Loads → **Use Roof (DL)**

Assign Lower Roof Load → Select Lower Roof

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	72'10"
Length:	36'0"	72'0"



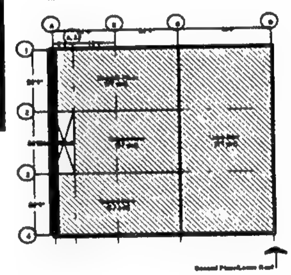
Stop Using Roof (DL)

Assign Exterior Wall Loads → **Use Wall (DL)**

Assign Exterior Wall Load → Select Exterior Wall

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	10"	72'10"
Length:	0'0"	72'0"



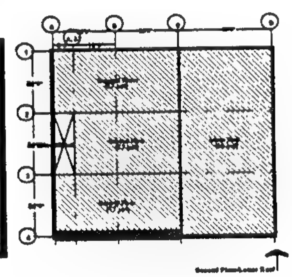
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	10"
Length:	48'0"	0'0"



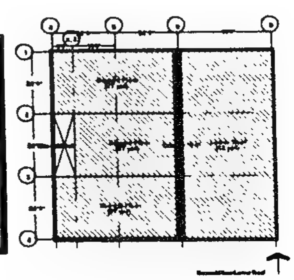
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	48'10"	72'10"
Length:	0'0"	72'0"



Assign Dead Loads

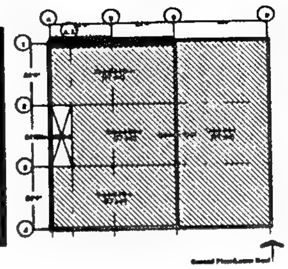
Assign Exterior Wall Loads

Wall Height
Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	48'10"	72'10"
Length:	48'0"	0'0"



Wall Height
Start: 14'0"
End: 14'0"

Assign Parapet Wall Loads

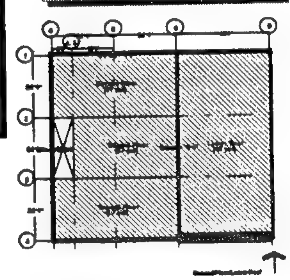
Use Wall (DL)

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	10"
Length:	36'0"	0'0"

Select Parapet Wall

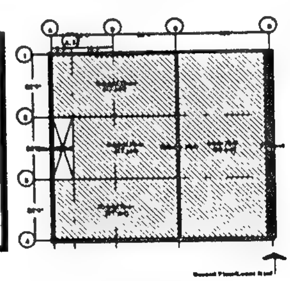


Wall Height
Start: 4'0"
End: 4'0"

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



Wall Height
Start: 4'0"
End: 4'0"

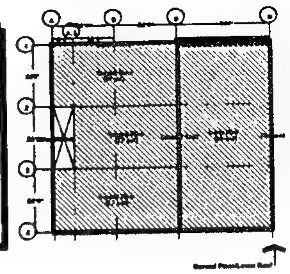
Assign Dead Loads

Assign Parapet Wall Loads

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	72'10"
Point 2:	84'10"	72'10"
Length:	36'0"	0'0"



Wall Height

Start: 4'0"
End: 4'0"

Stop Using Wall (DL)

Assign Upper Roof Loads

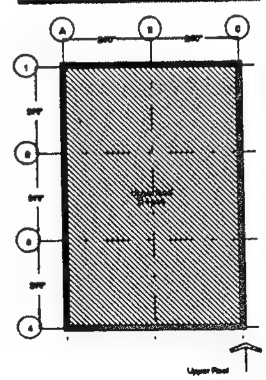
Select Upper Roof Horizontal Structural Plane

Use Roof (DL)

Assign Upper Roof Load

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	72'10"
Length:	48'0"	72'0"

Select Upper Roof



Stop Using Roof (DL)

Assign Ground Floor Wall Loads

Select Ground Floor Horizontal Structural Plane

Structural Plane Information

Name: Ground Floor

Assign Dead Loads

Assign Ground Floor Wall Loads

Close Structural Plane Information Dialog Window

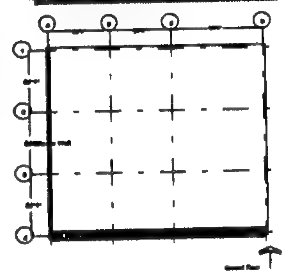
Use Wall (DL)

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	84'10"	10"
Length:	84'0"	0'0"

Select Exterior Wall



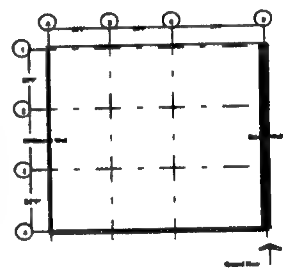
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



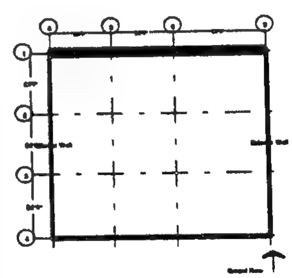
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

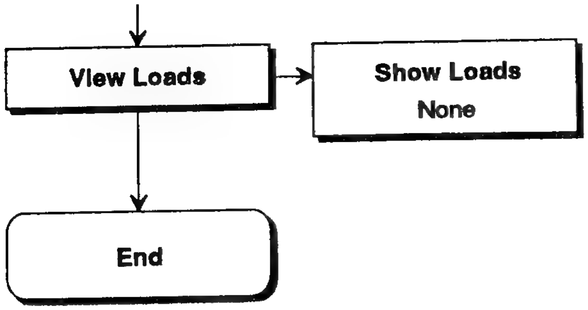
	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	84'10"	72'10"
Length:	84'0"	0'0"

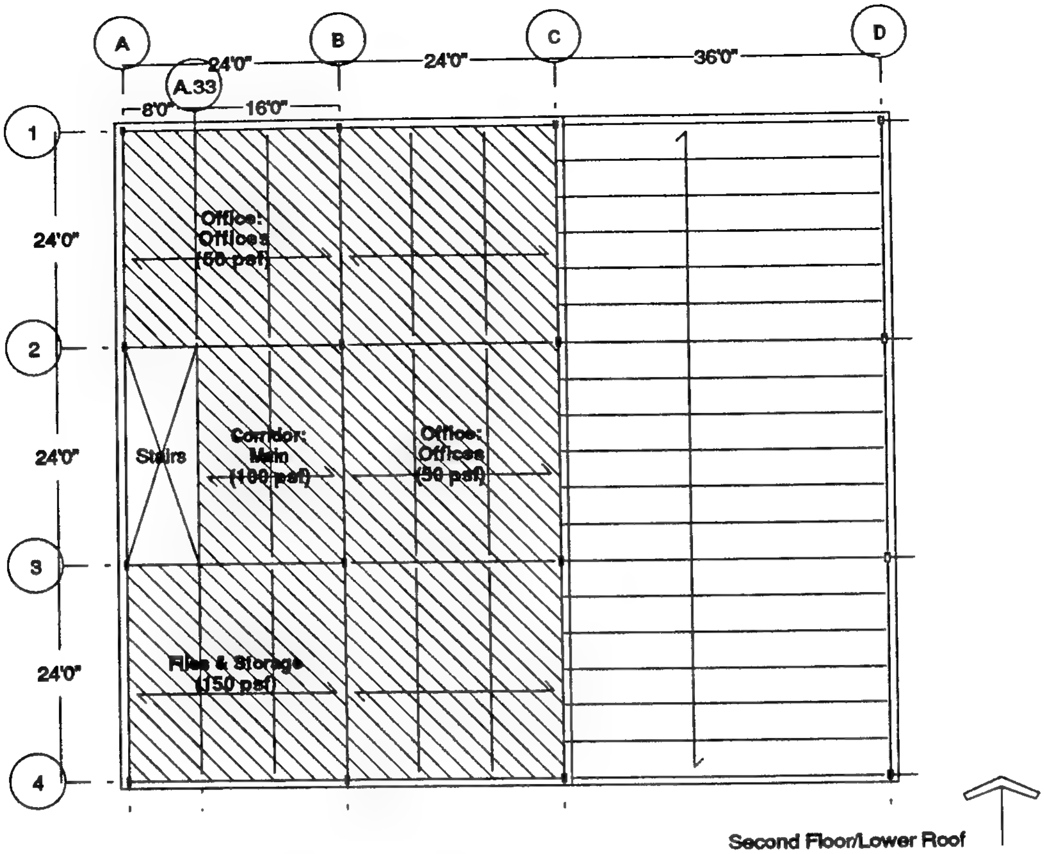


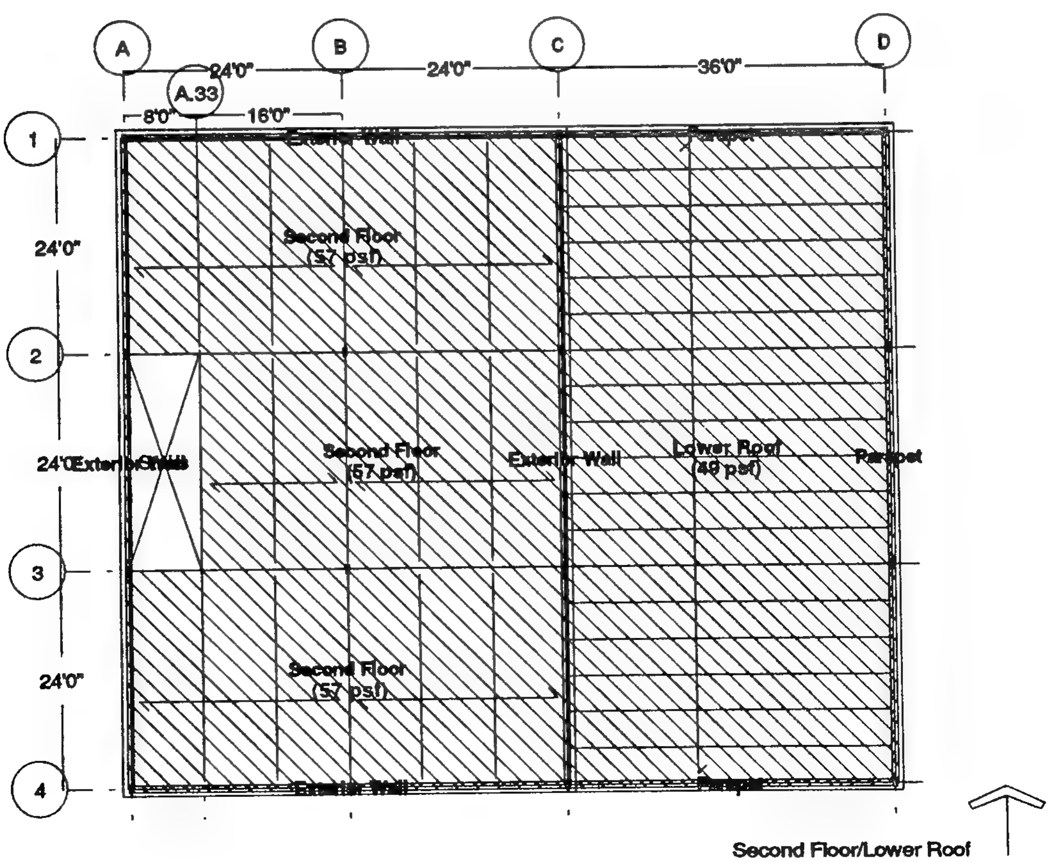
Wall Height

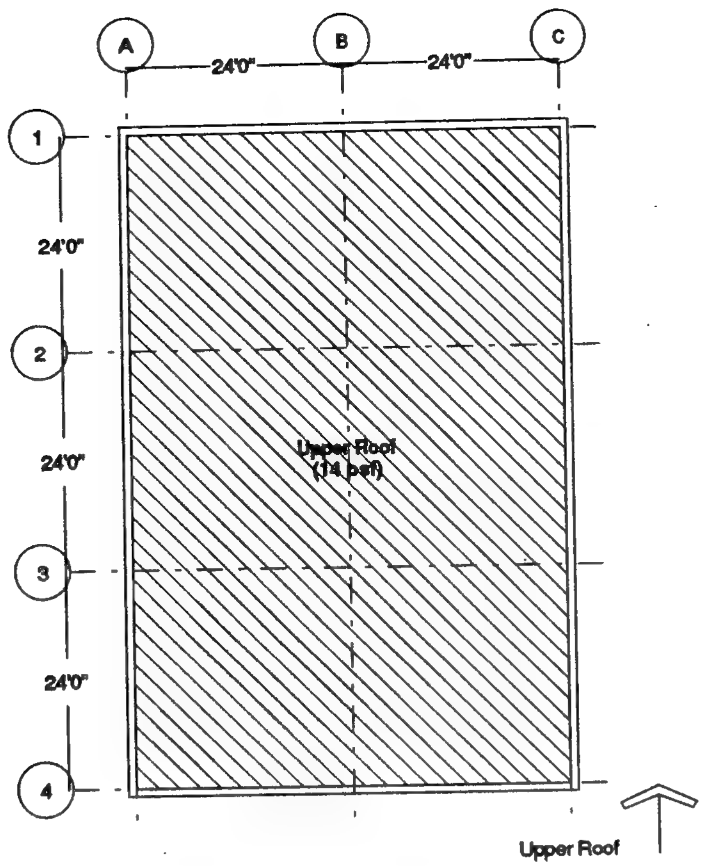
Start: 14'0"
End: 14'0"

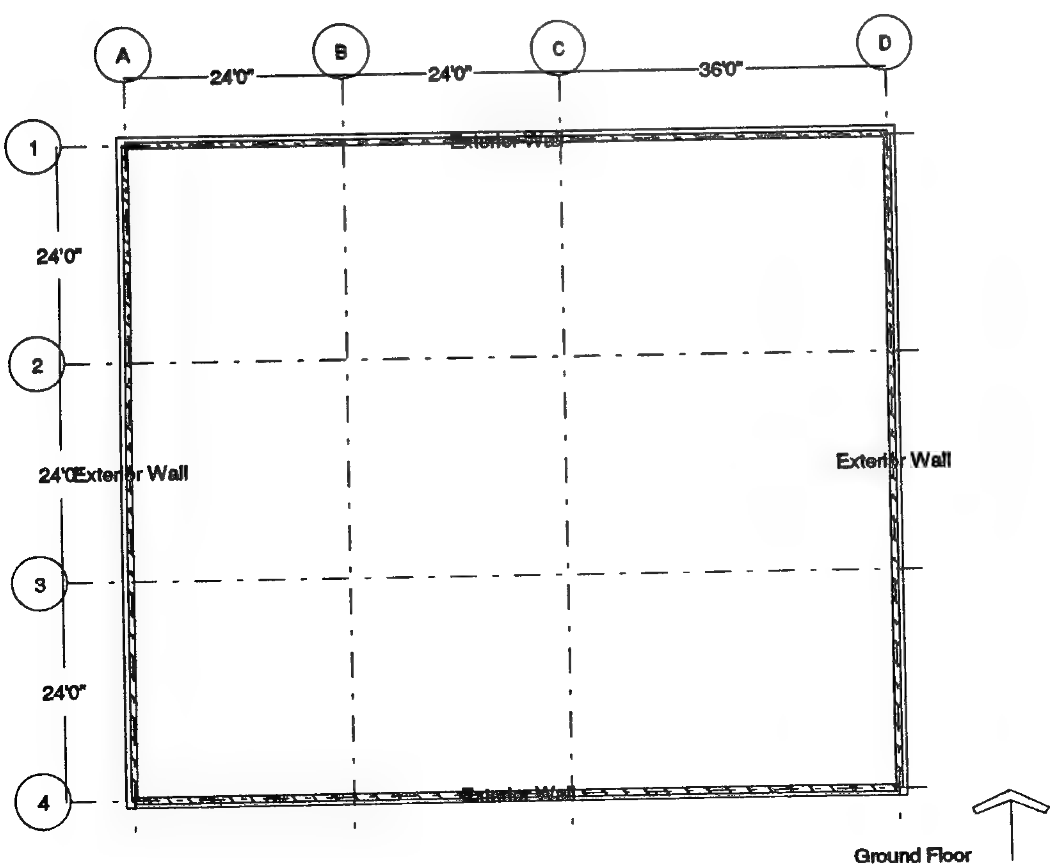
Stop Using Wall (DL)


View Loads
Show Loads
None
End


A
B
C
D
24'0"
24'0"
36'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Office:
Offices
(50 psf)
Stairs
Corridor:
Main
(100 psf)
Office:
Offices
(50 psf)
Files & Storage
(150 psf)
Second Floor/Lower Roof


A
B
C
D
24'0"
24'0"
36'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Parapet
Second Floor
(57 psf)
Exterior Wall
Stairs
Second Floor
(57 psf)
Exterior Wall
Lower Roof
(40 psf)
Parapet
Second Floor
(57 psf)
Exterior Wall
Parapet
Second Floor/Lower Roof

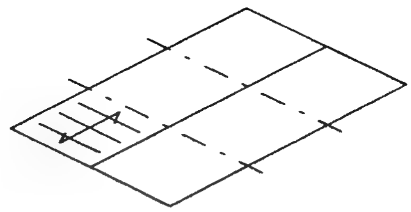

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof
(14 psf)
Upper Roof


A
B
C
D
24'0"
24'0"
36'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Exterior Wall
Exterior Wall
Exterior Wall
Ground Floor

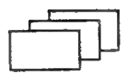
Analysis & Design Philosophy

Preliminary Analysis

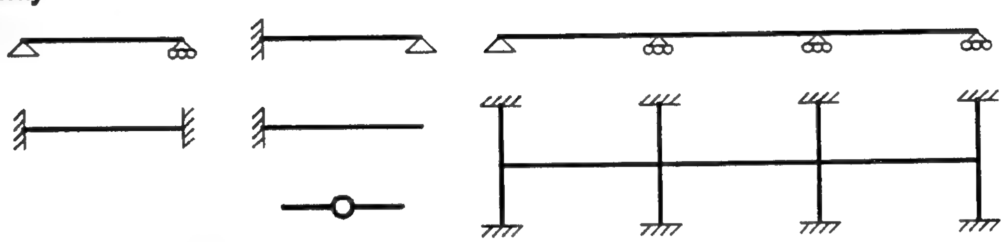
A. Select:
* Material
* Load Combination
  (Live Load Reduction)
* Element To Analyze



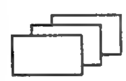
B. Review:
* Attributes
* Guidelines



C. Connectivity

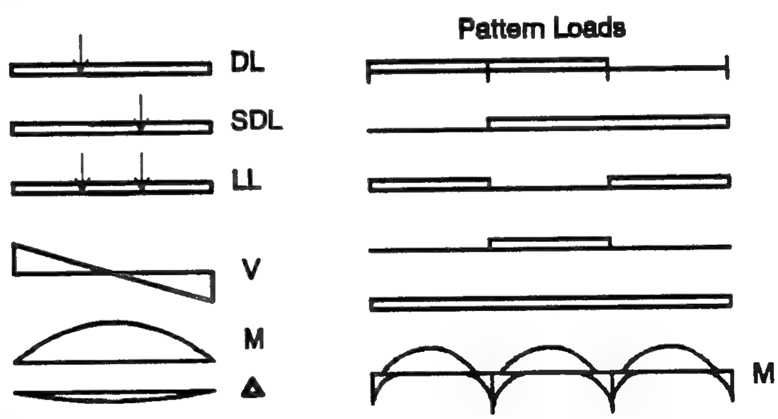


D. Self Weight Estimate * Guidelines



E. Analysis
* Review Loads
* Connectivity

* Analysis Output
  I = 1
  E = 1
  A = 1000

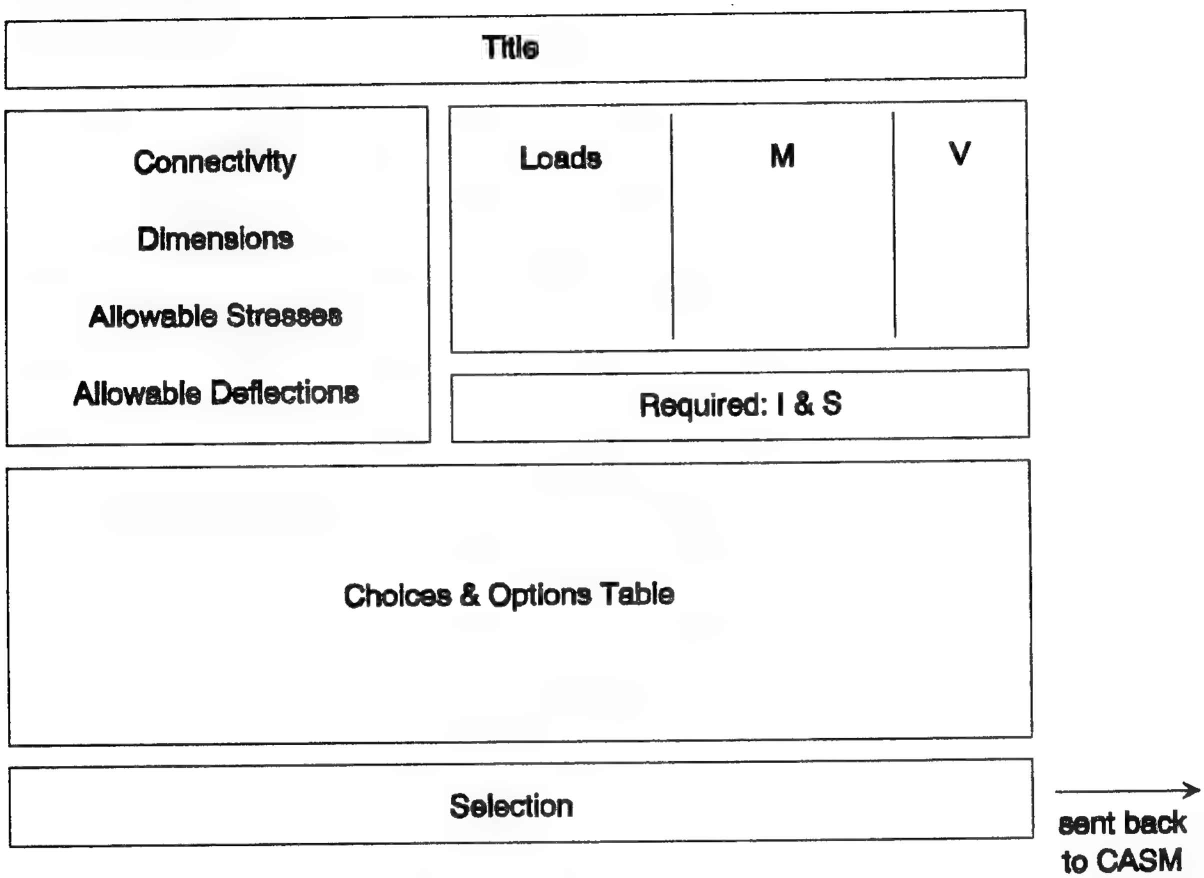


F. Re-Analysis (with real properties)

Preliminary Design

* Maximum V's, M's, R's, etc. sent to Excel

Spreadsheets



Surface Element Analysis

Start

↓

Use Loads & Design Tool Palette

↓

Select Upper Roof Horizontal Structural Plane

↓

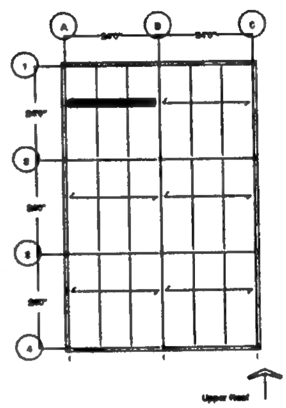
Material Steel

↓

Select Element To Analyze & Design → **Surface One-Way Roof Deck**

↓ **Select A One-Way Surface Element**

↓ **Review Element Attributes & Guidelines**



↓

Compare Min. Roof LL & Snow Loads → **Use Compare Min. Roof LL & Snow Loads**

↓ **Analysis**
Units: Feet & Pounds

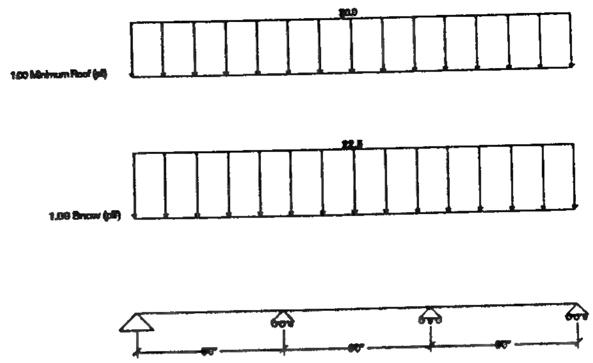
↓ **Decking Analysis**

Number Of Spans:	3
Distance From Edge:	12'
Starting Span Number:	1

↓ **Snow Load Options**
◉ Combined Snow Loads

↓ **Minimum Roof (LL)**

↓



Compare Min. Roof LL & Snow Loads

Compare Min. Roof LL & Snow Loads

View Shear, Moment & Deflection Diagrams

Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

Highlight D+S In List

Preliminary Analysis

Use Preliminary

Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight

Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1
☒ Include Superimposed Dead Load

Snow Load Options
◉ Combined Snow Loads

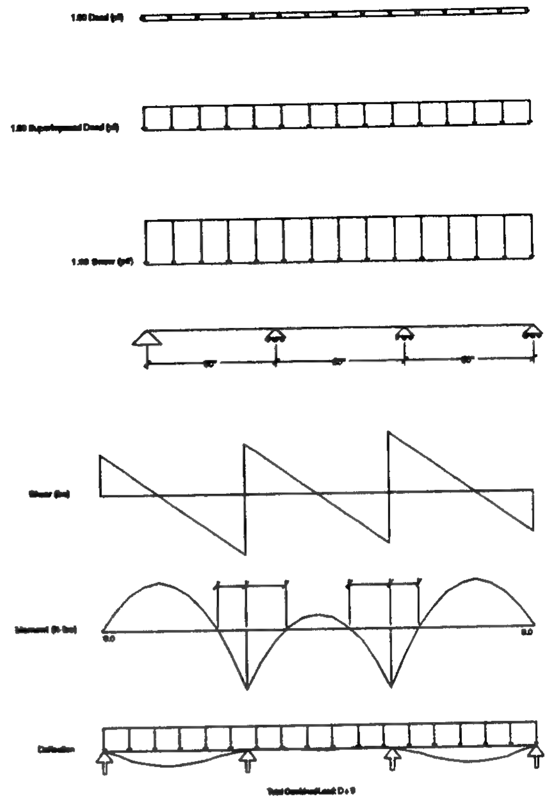
Preliminary Analysis

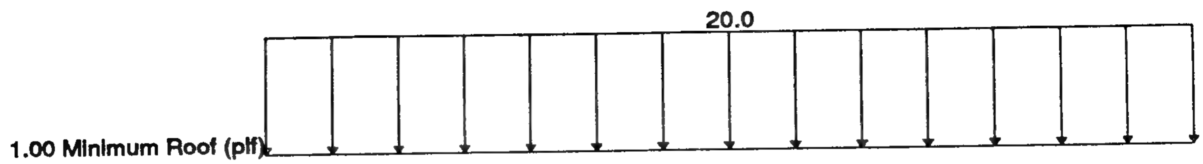
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

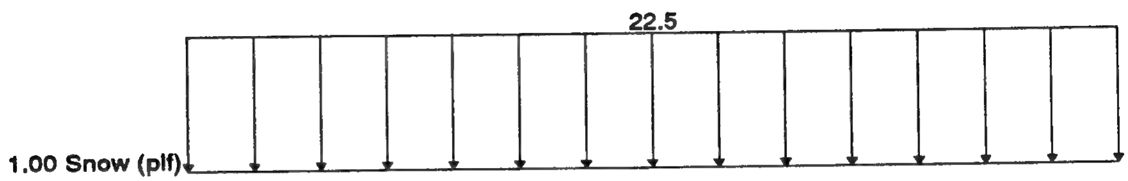
View Shear, Moment & Deflection Diagrams

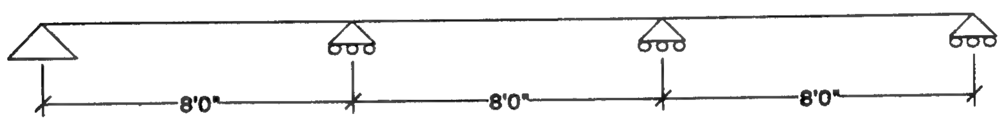
Excel Data
◉ Execute Excel

End

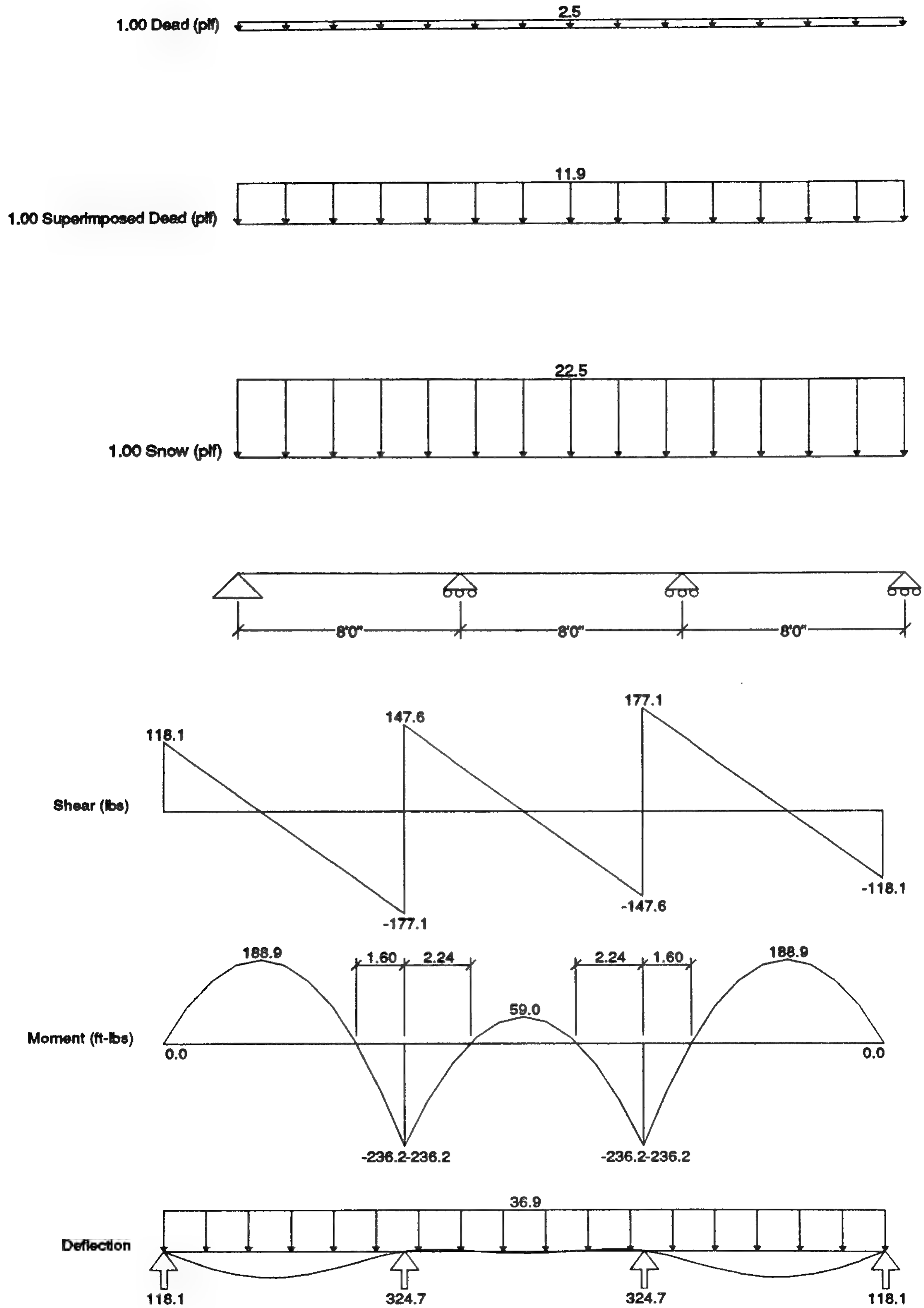






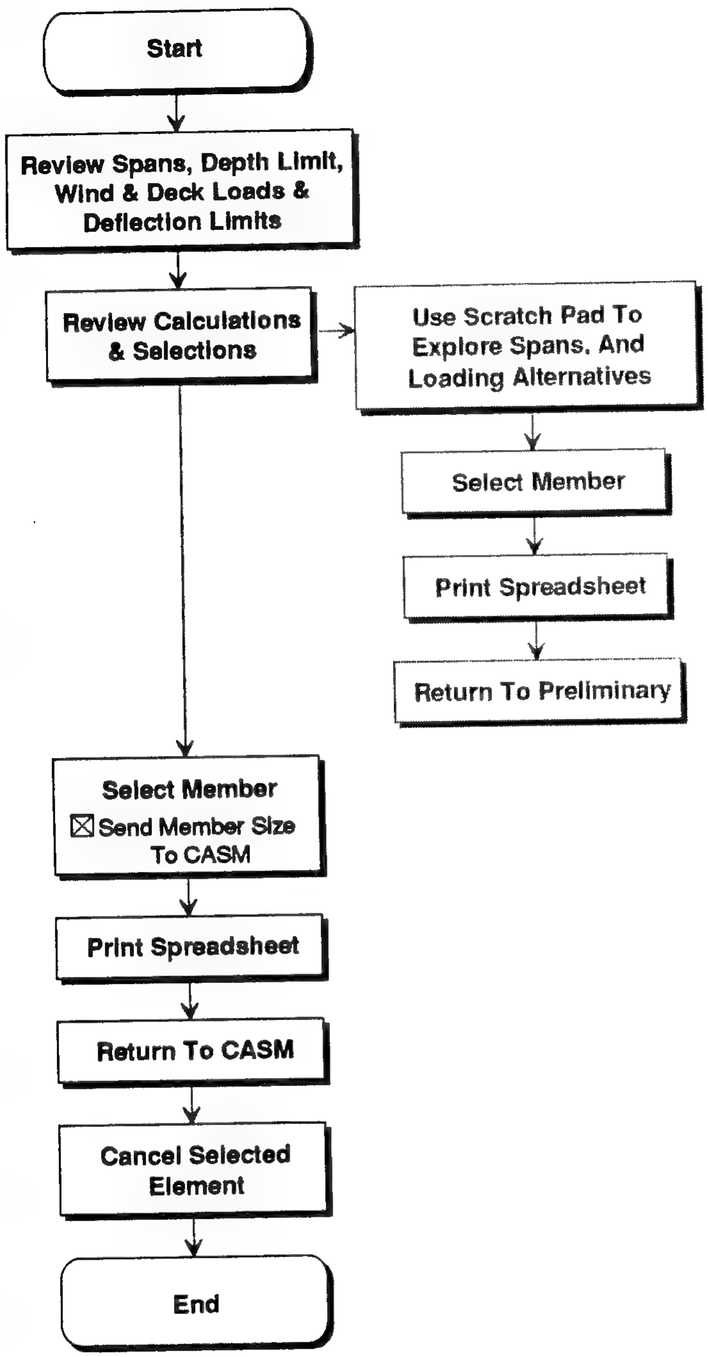



```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  12:08 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At)  : 24.0 sqft
Roof Slope     (F)   : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

Steel Roof Deck Design



STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Aug 31, 1994
Location: Radford AAP	Engr:

Load and Analysis Data:

Method: Analysis
Member ID:
Connectivity: Beam (Left)
Beam (Right)
Deck Span: 8 ft
Trib Width= 12 in
Depth Limit= 1.5 in. max
Fy= 33.0 ksi
Fb= 20.0 ksi
Fv= 13.2 ksi
E = 29,000 ksi
Live Ld Defl= L/240 =0.40 in
Total Defl= L/180 =0.53 in

Load Combination: D + S

Load Type	Factored Moments (lb-ft) Left	Mid	Right	Fact. Reactions Left(lb)	Right(lb)
Deck	16.0	12.8	16.0	12.0	12.0
Sup Dead	76.2	60.9	76.2	57.1	57.1
Live					
Lmin Roof					
Snow	144.0	115.2	144.0	108.0	108.0
Wind					
Summary	236.2	188.9	236.2	177.1	177.1

Load Combinations for roof:

Load Case #1:	D + S	Est. Deck Wgt =	2.0 psf
Load Case #2:	Deck + Wind	Wind Load =	-30.0 psf
Load Case #3:	Deck + Construction 200# Point Load		

Deck Configuration:

Deck Type: Roof Deck

Code Load Combinations:

	Case	Load (psf)	Fb Factor	M+ (f-lb)	M- (f-lb)	S+ (in.3)	S- (in.3)	Ix (in.4)
Number of spans = 3	# 1		1.00	188.9	92.2	0.113	0.055	0.1531
	# 2	-28.0	1.33	209.7	-168.4	0.095	-0.076	0.1263
	# 3	2.0	1.33	332.0	-183.0	0.150	-0.083	0.1716
Maximums:				332.0	-183.0	0.150	-0.083	0.1716

Steel Roof Deck Selection Table - Spans = 3

Deck Type	Gage	Depth (in)	Sx+ (in.^3)	Sx- (in.^3)	Ix (in.^4)	Dk wgt (psf)	Const Span Limit 1 Span	2+Span
WR 20	20	1.5	0.232	-0.245	0.210	2.1	6'-3"	7'-5"
IR18	18	1.5	0.189	-0.194	0.206	2.7	6'-2"	7'-4"
WR18	18	1.5	0.316	-0.325	0.290	2.8	7'-6"	8'-10"
NR18	18	1.5	0.163	-0.168	0.188	2.8	5'-11"	6'-11"

CASM Preliminary Steel Roof Deck Selection:

Deck Type: WR 20	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc	
Weight: 2.1 psf	Gage: 20	Ix = 0.21	Construction Load Span Limits:	
	Sx+ = 0.232	Sx- = -0.245	1 span: 6'-3"	2+span: 7'-5"

Notes:

1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

Narrowly Spaced Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

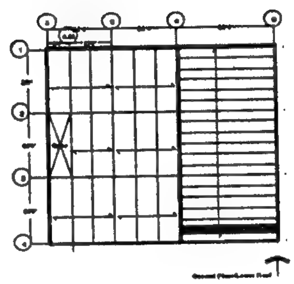
Material Steel

Select Element To Analyze & Design

Linear Narrowly Spaced Open-Web Joists-K

Select A Narrowly Spaced Element Near A Corner

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

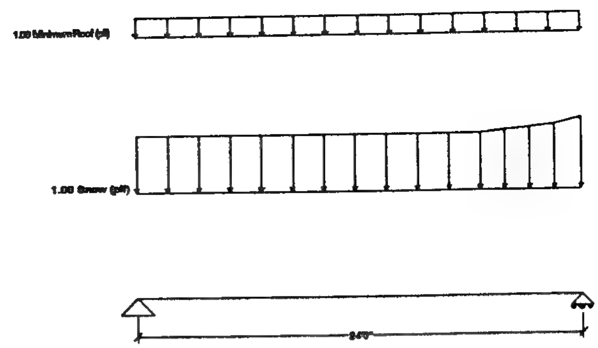
Use Compare Min. Roof LL & Snow Loads

Analysis
Units: Feet & Pounds

Connectivity
Left: Hinge
Right: Roller

Snow Load Options
◉ Combined Snow Loads

Minimum Roof (LL)



Compare Min. Roof LL & Snow Loads

Compare Min. Roof LL & Snow Loads

View Shear, Moment & Deflection Diagrams

Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

Highlight D+S In List

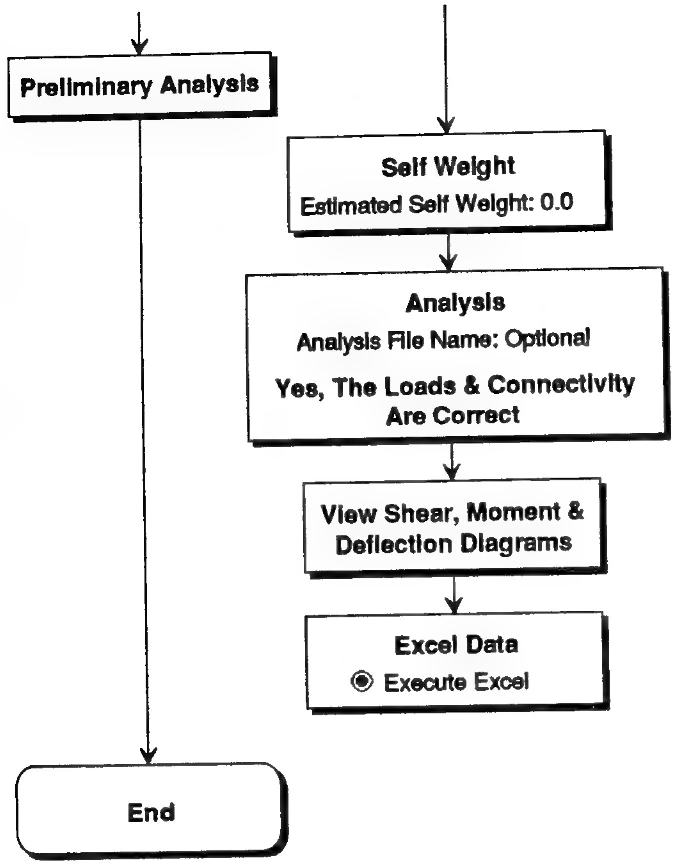
Preliminary Analysis

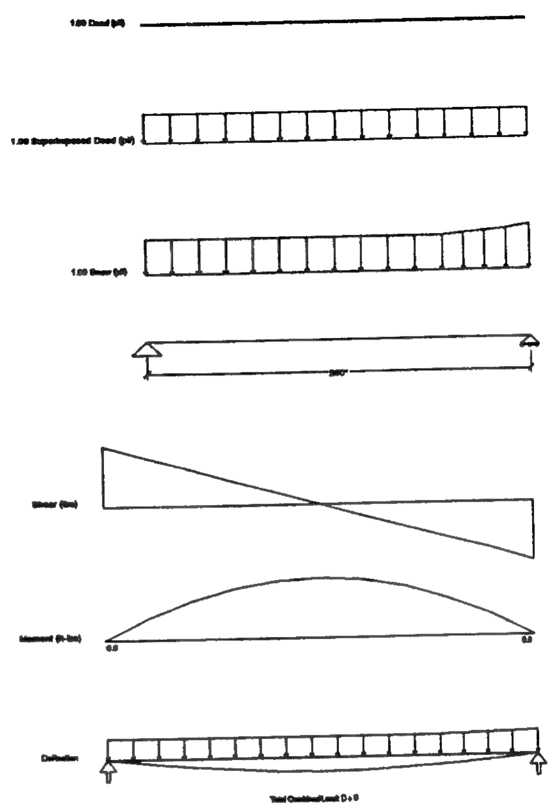
Use Preliminary

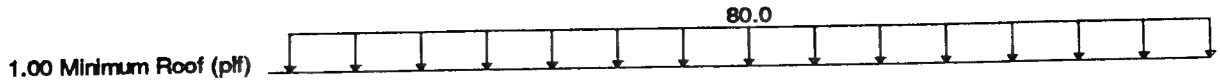
Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight

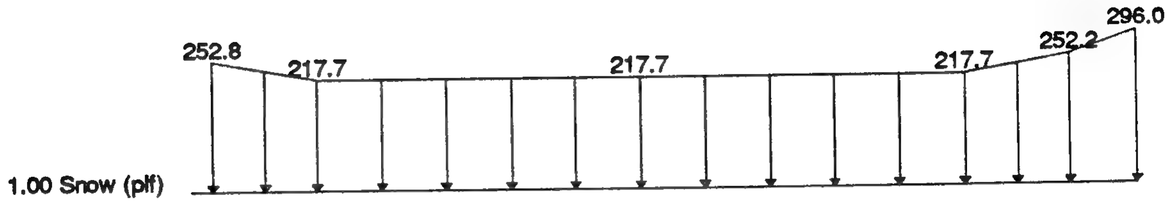
Connectivity
Left: Hinge
Right: Roller

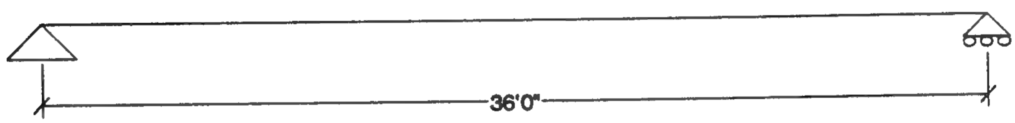
Snow Load Options
◉ Combined Snow Loads


Preliminary Analysis
Self Weight
Estimated Self Weight: 0.0
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End







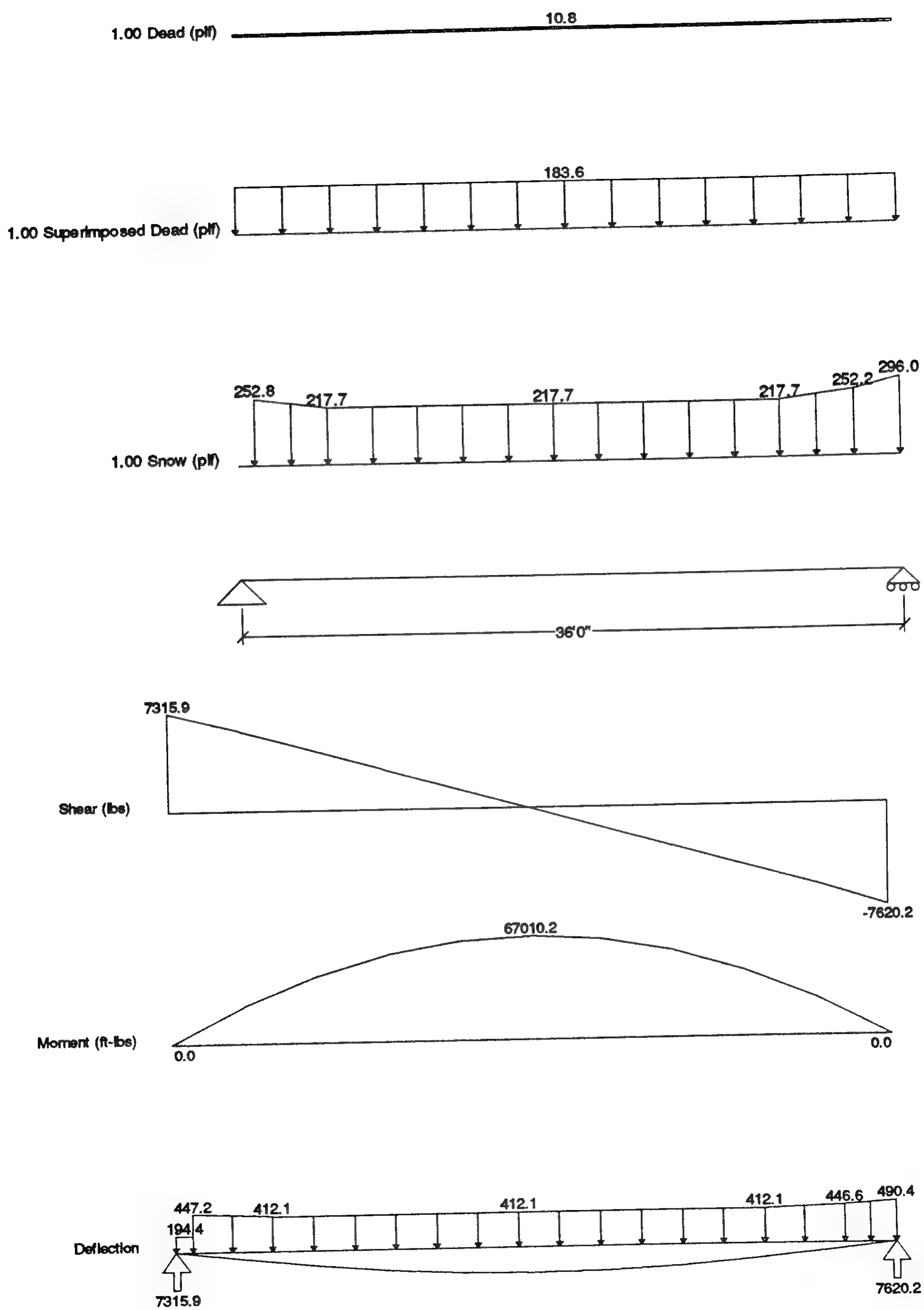



```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994   4:45 PM

************************ Minimum Roof Live Load (Lr) ************************

Tributary Area (At) : 144.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
```

Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Narrowly Spaced Element Analysis



Total Combined Load: D + S

```
*********************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
*********************************************


2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994  4:52 PM


********************************** I N P U T **********************************
```

Office Building - Scheme B -- 1.00 Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	3.60	-10.80	0.00		3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	19.440	11.664	0.000	19.440	-11.664

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.60	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

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******************************** O U T P U T ********************************
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JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-3023.3089
2	0.0000	-128125.4106	-2854.0036
3	0.0000	-242406.4852	-2394.4606
4	0.0000	-331872.2408	-1717.2394
5	0.0000	-388686.2608	-894.8994
6	0.0000	-408146.6952	0.0000
7	0.0000	-388686.2608	894.8994
8	0.0000	-331872.2408	1717.2394
9	0.0000	-242406.4852	2394.4606
10	0.0000	-128125.4106	2854.0036
11	0.0000	0.0000	3023.3089

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	194.400	0.000	0.000	-155.520	629.856
2	0.000	155.520	-629.856	0.000	-116.640	1119.744
3	0.000	116.640	-1119.744	0.000	-77.760	1469.664
4	0.000	77.760	-1469.664	0.000	-38.880	1679.616
5	0.000	38.880	-1679.616	0.000	0.000	1749.600
6	0.000	0.000	-1749.600	0.000	38.880	1679.616
7	0.000	-38.880	-1679.616	0.000	77.760	1469.664
8	0.000	-77.760	-1469.664	0.000	116.640	1119.744
9	0.000	-116.640	-1119.744	0.000	155.520	629.856
10	0.000	-155.520	-629.856	0.000	194.400	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	194.400	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	194.400	0.000

PROBLEMS COMPLETED

```
*********************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
*********************************************


2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994  4:52 PM


********************************** I N P U T **********************************
```

Office Building - Scheme B -- 1.00 Superimposed Dead Load

NUMBER OF ELEMENTS = 10
NUMBER OF NODAL POINTS = 11
NUMBER OF MATERIALS = 1
NUMBER OF ELEMENT TYPES = 1
NUMBER OF ELASTIC SUPPORT TYPES = 0
NUMBER OF FIXED END FORCE TYPES = 1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	3.60	-183.60	0.00		3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	330.480	198.288	0.000	330.480	-198.288

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.60	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

********************************* O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-51396.2478
2	0.0000	-2178131.8664	-48518.0580
3	0.0000	-4120910.0347	-40705.8283
4	0.0000	-5641827.8007	-29193.0688
5	0.0000	-6607666.0900	-15213.2894
6	0.0000	-6938493.4581	0.0000
7	0.0000	-6607666.0900	15213.2894
8	0.0000	-5641827.8007	29193.0688
9	0.0000	-4120910.0347	40705.8283
10	0.0000	-2178131.8664	48518.0580
11	0.0000	0.0000	51396.2478

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3304.800	0.000	0.000	-2643.840	10707.552
2	0.000	2643.840	-10707.552	0.000	-1982.880	19035.647
3	0.000	1982.880	-19035.647	0.000	-1321.920	24984.287
4	0.000	1321.920	-24984.287	0.000	-660.960	28553.471
5	0.000	660.960	-28553.471	0.000	0.000	29743.199
6	0.000	0.000	-29743.199	0.000	660.960	28553.471
7	0.000	-660.960	-28553.471	0.000	1321.920	24984.287
8	0.000	-1321.920	-24984.287	0.000	1982.880	19035.647
9	0.000	-1982.880	-19035.647	0.000	2643.840	10707.552
10	0.000	-2643.840	-10707.552	0.000	3304.800	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3304.800	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	3304.800	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994 4:52 PM

********************************* I N P U T ********************************

Office Building - Scheme B -- 1.00 Snow Load

NUMBER OF ELEMENTS = 10
NUMBER OF NODAL POINTS = 11
NUMBER OF MATERIALS = 1
NUMBER OF ELEMENT TYPES = 1
NUMBER OF ELASTIC SUPPORT TYPES = 0
NUMBER OF FIXED END FORCE TYPES = 5

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	RAMP	3.60	-252.80	0.83	-228.38	3.60
2	UNIFRM	3.60	-217.70	1.21		3.60
2	RAMP	3.60	-228.38	0.00	-217.70	1.21
3	UNIFRM	3.60	-217.70	0.00		3.60
4	UNIFRM	3.60	-217.70	0.00		0.66
4	RAMP	3.60	-217.70	0.66	-243.05	3.60
5	RAMP	3.60	-243.05	0.00	-252.21	1.06
5	RAMP	3.60	-252.21	1.06	-296.00	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	247.449	203.538	0.000	418.190	-249.101
2	0.000	398.004	236.933	0.000	392.173	-235.464
3	0.000	391.856	235.114	0.000	391.856	-235.114
4	0.000	400.216	242.714	0.000	420.750	-249.112
5	0.000	459.218	280.691	0.000	499.447	-293.057

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.60	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	4	4.00	4.00	0.50
10	10	11	1	1	0	5	4.00	4.00	0.50

*********************************** O U T P U T ***********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-61411.3760
2	0.0000	-2602732.7518	-57975.3350
3	0.0000	-4924253.1523	-48646.1547
4	0.0000	-6742314.4791	-34910.9089
5	0.0000	-7898171.3665	-18232.3078
6	0.0000	-8296262.9413	-72.9476
7	0.0000	-7904212.4932	18104.5754
8	0.0000	-6752827.4745	34837.6646
9	0.0000	-4936099.5002	48663.7239
10	0.0000	-2611231.5820	58116.2957
11	0.0000	0.0000	61647.5956

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3816.687	0.000	0.000	-3151.048	12803.693
2	0.000	3151.048	-12803.693	0.000	-2360.871	22716.119
3	0.000	2360.871	-22716.119	0.000	-1577.158	29804.571
4	0.000	1577.158	-29804.571	0.000	-793.445	34071.657
5	0.000	793.445	-34071.657	0.000	-9.732	35517.376
6	0.000	9.732	-35517.376	0.000	773.981	34141.729
7	0.000	-773.981	-34141.729	0.000	1557.694	29944.715
8	0.000	-1557.694	-29944.715	0.000	2341.406	22926.335
9	0.000	-2341.406	-22926.335	0.000	3162.373	13050.094
10	0.000	-3162.373	-13050.094	0.000	4121.038	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3816.687	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	4121.038	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994 4:52 PM

********************************** I N P U T **********************************

Office Building - Scheme B -- Total Combined Load: D + S

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	5

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	3.60	-194.40	0.00		3.60
1	RAMP	3.60	-252.80	0.83	-228.30	3.60
2	UNIFRM	3.60	-194.40	0.00		3.60
2	UNIFRM	3.60	-217.70	1.21		3.60
2	RAMP	3.60	-228.30	0.00	-217.70	1.21
3	UNIFRM	3.60	-412.10	0.00		3.60
4	UNIFRM	3.60	-194.40	0.00		3.60
4	UNIFRM	3.60	-217.70	0.00		0.66
4	RAMP	3.60	-217.70	0.66	-243.05	3.60
5	UNIFRM	3.60	-194.40	0.00		3.60
5	RAMP	3.60	-243.05	0.00	-252.21	1.06
5	RAMP	3.60	-252.21	1.06	-296.00	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	597.369	413.490	0.000	768.110	-459.053
2	0.000	747.924	446.885	0.000	742.093	-445.416
3	0.000	741.776	445.066	0.000	741.776	-445.066
4	0.000	750.136	452.666	0.000	770.670	-459.064
5	0.000	809.138	490.643	0.000	849.367	-503.009

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS: NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.60	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	4	4.00	4.00	0.50
10	10	11	1	1	0	5	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-115830.9327
2	0.0000	-4908990.0280	-109347.3965
3	0.0000	-9287569.6722	-91746.4436
4	0.0000	-12716014.5206	-65821.2171
5	0.0000	-14894523.7173	-34340.4966
6	0.0000	-15642903.0947	-72.9476
7	0.0000	-14900564.8441	34212.7641
8	0.0000	-12726527.5160	65747.9728
9	0.0000	-9299416.0201	91764.0128
10	0.0000	-4917488.8589	109488.3572
11	0.0000	0.0000	116067.1523

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	7315.886	0.000	0.000	-5950.408	24141.100
2	0.000	5950.408	-24141.100	0.000	-4460.391	42871.510
3	0.000	4460.391	-42871.510	0.000	-2976.838	56258.522
4	0.000	2976.838	-56258.522	0.000	-1493.285	64304.744
5	0.000	1493.285	-64304.744	0.000	-9.732	67010.175
6	0.000	9.732	-67010.175	0.000	1473.821	64374.816
7	0.000	-1473.821	-64374.816	0.000	2957.374	56398.666
8	0.000	-2957.374	-56398.666	0.000	4440.926	43081.727
9	0.000	-4440.926	-43081.727	0.000	5961.733	24387.502
10	0.000	-5961.733	-24387.502	0.000	7620.238	0.000

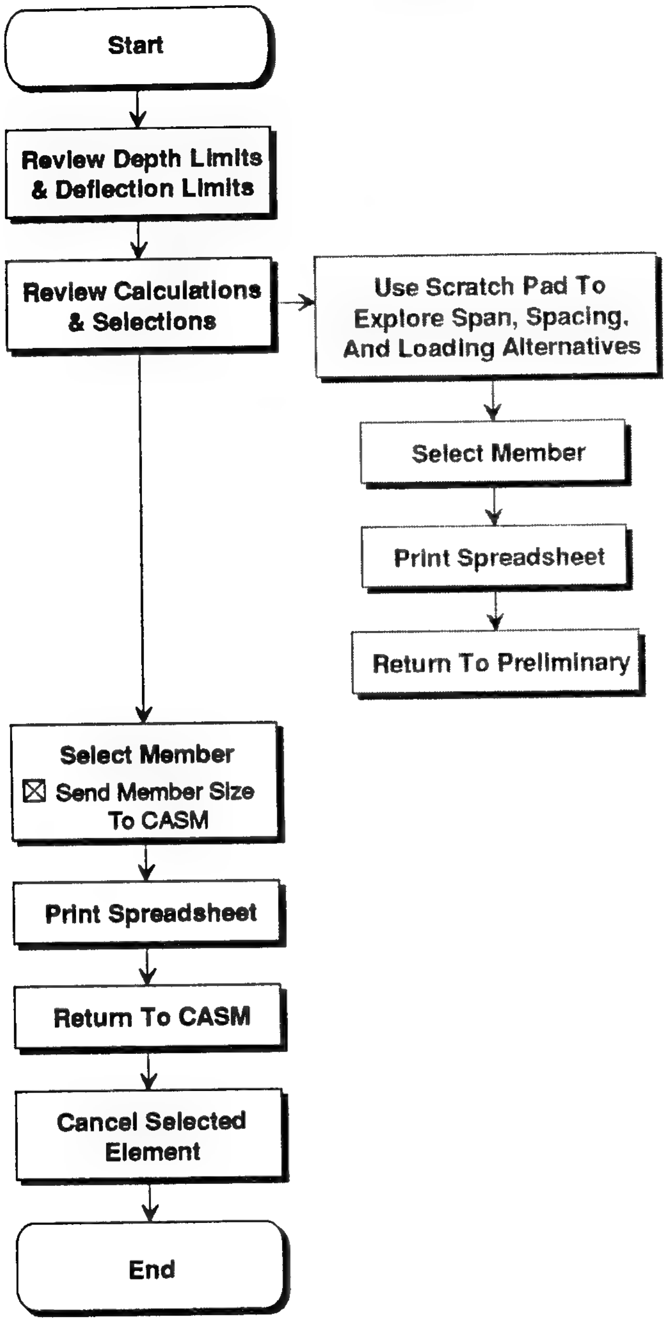
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	7315.886	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	7620.238	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date: Sep 01, 1994**
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis — Load Combination D + S

			Factored Moment (ft-lb)			Factored Reaction	
Member ID:		LoadType	Left	Mid	Right	Left(lb)	Right(lb)
Connection:	Hinge (Left) Roller (Right)	Dead		1,750		194	194
Span:	36.0 ft	Sup Dead		29,743		3,305	3,305
Spacing:	48.0 in	Live					
Depth Limit=	30.0 in. max	Lmin Roof					
Fy=	50.0 ksi	Snow		35,517		3,817	4,121
Fb=	30.0 ksi	Wind					
E =	29,000 ksi	Summary		67,010		7,316	7,620
Live Defl=	L/360= 1.20 in	Moment EUL:	Total Ld= 414 plf		Reaction EUL:	Total Ld= 423 plf	
Total Defl=	L/240= 1.80 in		Live Ld= 219 plf			Live Ld= 229 plf	
Ponding Check:	NO						

CASM Joist Selection Table: (joist capacities)

Joist Size	Spacing (in)	Total Ld(plf)	Live Ld(plf)	Mmax (ftlb)	Rmax (lb)	Live Ld Defl(in)	Total Ld Defl(in)	Ponding	Jst Wgt (plf)
28K9	48.0	442	332	71,604	7,956	0.83	1.54		13.0
24K10	48.0	447	283	72,414	8,046	0.97	1.79		13.1
30K8	48.0	436	353	70,632	7,848	0.78	1.45		13.2
30K9	48.0	475	383	76,950	8,550	0.72	1.34		13.4

CASM Bar Joist Selection:

Joist Size: **28K9**	Span: 36.0 ft	Spacing: 48 in	TL defl: 1.54 in	LL defl: 0.83 in
Wgt(tons): 0.23	Mmax: 71,604	Rmax: 7,956	Total Ld: 442 plf	Live Ld: 332 plf

NOTES:

1. Bar joist selections based on 1993 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.
2. Approximate moment of inertia of the joist in inches^4 is:
   Ij = 26.767 (WLL) (L^3) (10^-6), where WLL = Live Load value in table;
   where L = Span - 0.33 in feet
3. Ponding check based on SJI Technical Digest. Refer to AISC Commentary section K2 for charts for Stress Constant U and Flexibility Constant C for joists bearing on beams.
   a. For joists bearing on steel beams, Cs must be greater than Csreq. This is not an automatic selection. Beam size and/or joist size may need to be increased.
   b. For joists bearing on walls, the ponding load includes dead load plus percentage of live load, plus computed ponding load. Selection is based on greatest load.

Widely Spaced Element Analysis: Beam

Start

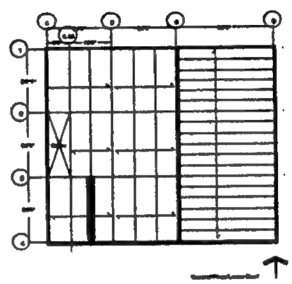
Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Select Element To Analyze & Design

- Linear Widely Spaced Composite Beam/Slab
- Select A Widely Spaced Element In Bay A3-B4
- Review Element Attributes & Guidelines



Load Combination D + L

- Use Load Combination
- Set Factors
  - Dead: 1.0
  - Live: 1.0
- Add
- OK Button To Close Dialog Window
- Highlight D+L In List

Preliminary Analysis

Use Preliminary

Analysis
Units: Feet & Pounds
Load Combination: D+L
☐ Apply Live Load Reduction
☐ Pattern Occupancy Live Load
☐ Use Actual Properties
☒ DL=Deck+Self Weight

Guidelines

Connectivity
Left: Hinge
Right: Roller

Self Weight

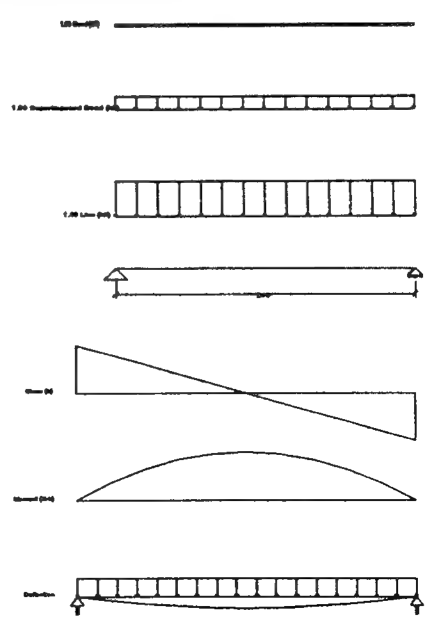
Guidelines

Find Estimate For 24' Span & 1.31 klf

Close Self Weight Guidelines Dialog Window

Self Weight
Estimated Self Weight: 30 plf
☒ Update Area Structure Loads
☒ Add Self Weight

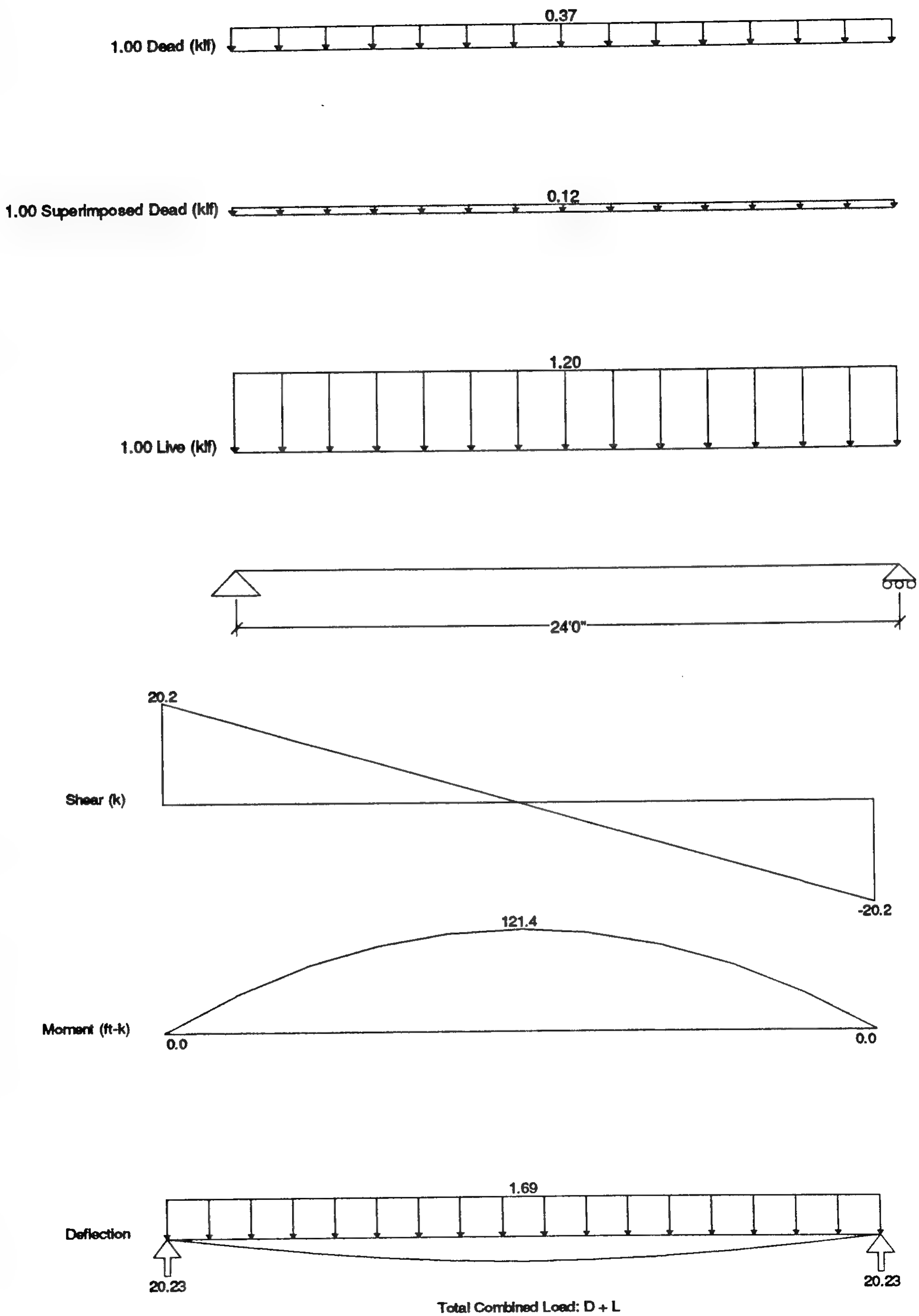
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct



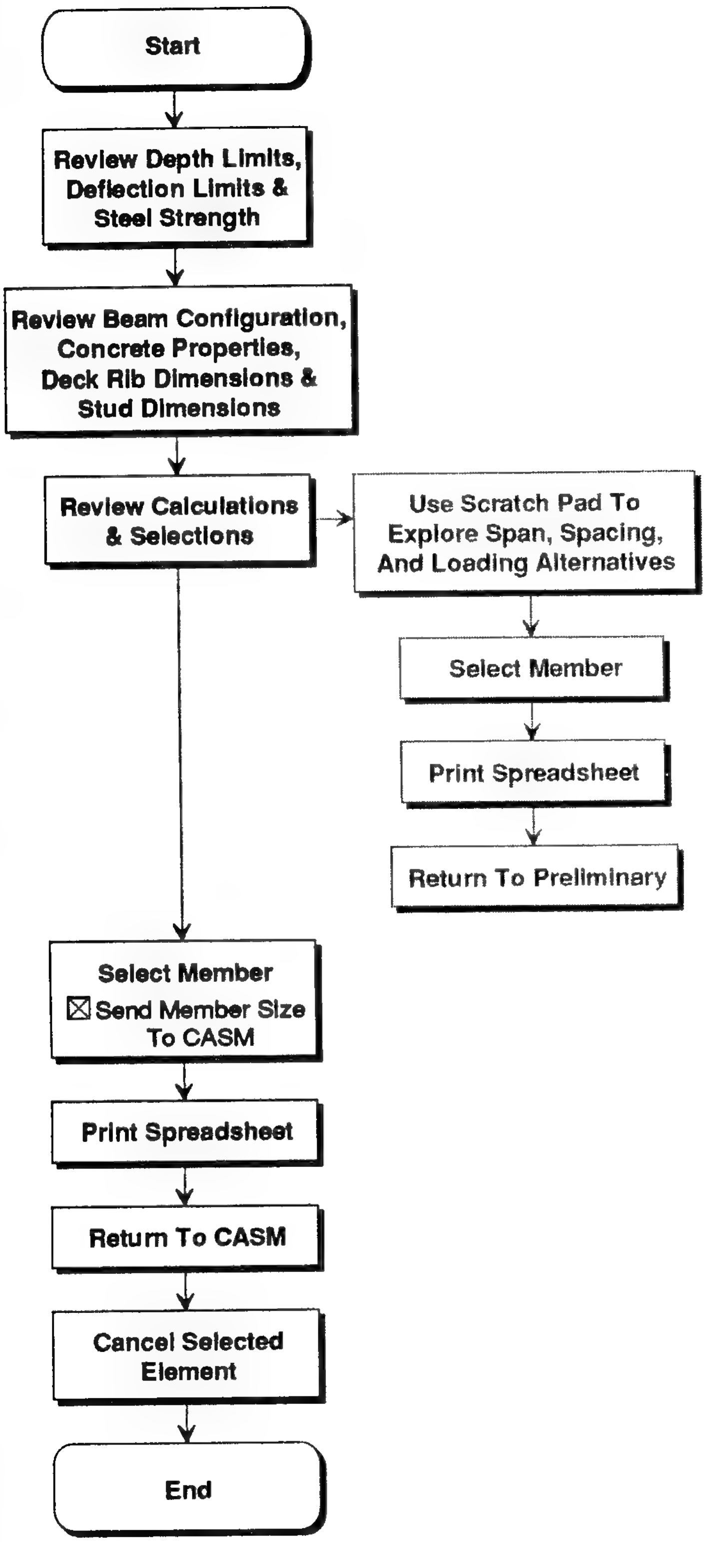
View Shear, Moment & Deflection Diagrams

Excel Data
◉ Execute Excel

End


0.37
1.00 Dead (klf)
0.12
1.00 Superimposed Dead (klf)
1.20
1.00 Live (klf)
24'0"
20.2
Shear (k)
-20.2
121.4
Moment (ft-k)
0.0
0.0
1.69
Deflection
20.23
20.23
Total Combined Load: D + L

Composite Steel Beam Design



STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B Location: Radford AAP	Date: Sep 01, 1994 Engr:

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left)
Roller (Right)
Beam Span: 24.0 ft
Trib Width= 8.0 ft
Depth Limit= 36.0 in. max
Fy= 36.0 ksi
Fb=Fy*0.66= 24.0 ksi
Fy * 0.89= 32.0 ksi
Fv= 14.4 ksi
Es= 29,000 ksi

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		26.4		4.4	4.4
Sup Dead		8.6		1.4	1.4
Live		86.4		14.4	14.4
Lmin Roof					
Snow					
Wind					
Summary		121.4		20.2	20.2

Deflection Limits:

Live Load=	L/360	=0.80 in
Total Load=	L/240	=1.20 in

Reqd Section Properties:

Ss(req)=	23	in^3
Str(req)=	61	in^3
Composite percent=	100 %	

Composite Properties:			Beam		
f'c=	4.0	ksi	Rib Spacing=	6.00	in
.45f'c=	1.8	ksi	Rib Width=	2.50	in
Wc=	145	pcf	Rib Height=	1.50	in
Ltwt conc coef=	1.0		Studs/rib=	1	
Ec=	3,644	ksi	Stud Diameter=	0.75	in
n=	8.0		Stud Length=	4.0	in
Slab ts=	5.50	in	Reduct. Factor=	1.00	
Slab bE=	72.0	in	Shear Cap=	13.3	kips

CASM Beam Selection Table:

Beam Size	Ss in^3	Dead Ld Defl(in)	Seff in^3	Conc fc (psi)	Steel fs (psi)	Ieff in^4	L + SD Defl(in)	# of Studs	Min % Comp.
W 8 x 35	31.2	-0.74	63.7	0.83	22.87	634	-0.54	28	82
W 10 x 30	32.4	-0.55	62.0	0.70	23.48	760	-0.45	24	91
W 10 x 33	35.0	-0.55	65.8	0.72	22.14	754	-0.45	28	70
W 14 x 26	35.3	-0.38	63.3	0.56	23.00	987	-0.34	22	82
W 8 x 40	35.5	-0.65	71.6	0.78	20.33	708	-0.48	32	49

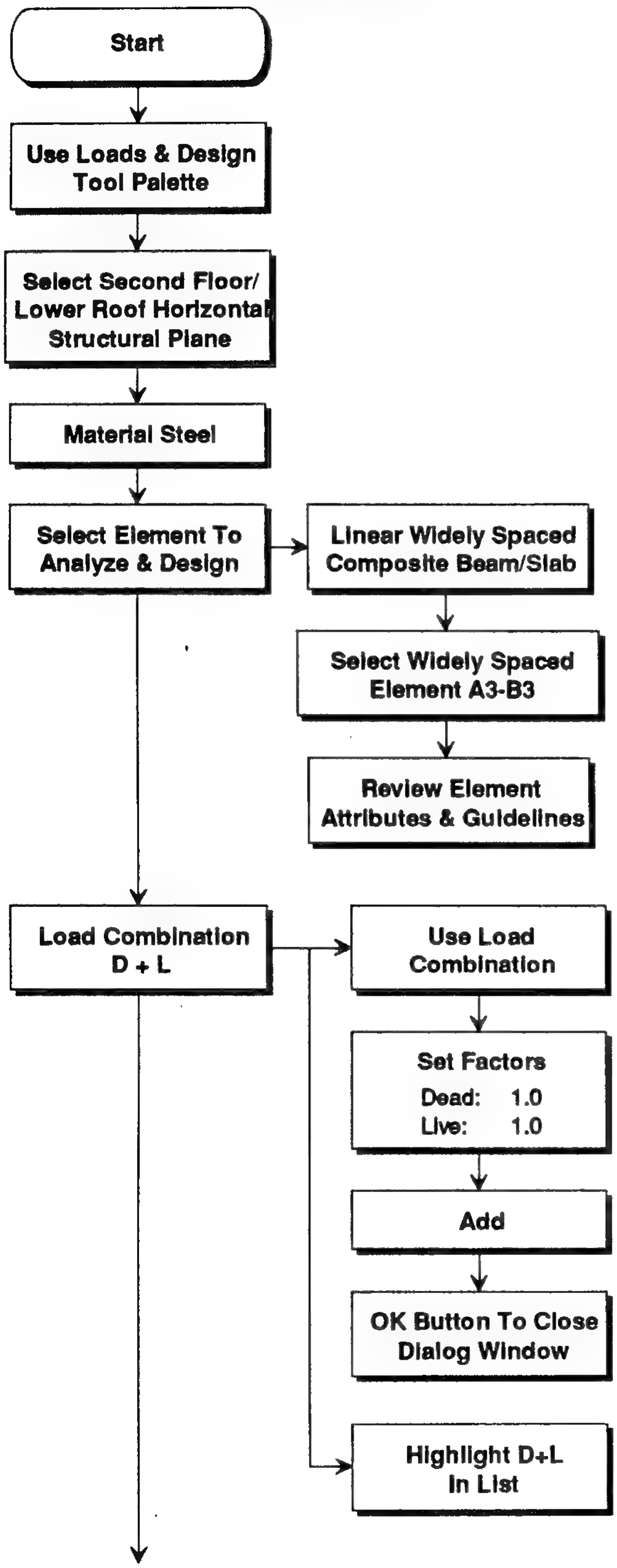
CASM Steel Beam Selection:

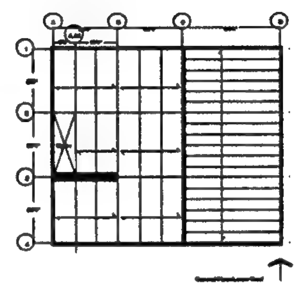
					Live Ld	Total
W 14 x 26	Span= 24.0 ft	Seff(in3)= 63.3	Ieff(in4)= 987	Defl(in)=	-0.34	-0.73
Shores Reqd: No	Nstuds= 22 (full)	Partial: (100 %)	Nstuds= 22		fv=	5.7ksi
				Beam Wgt=	0.31	tons

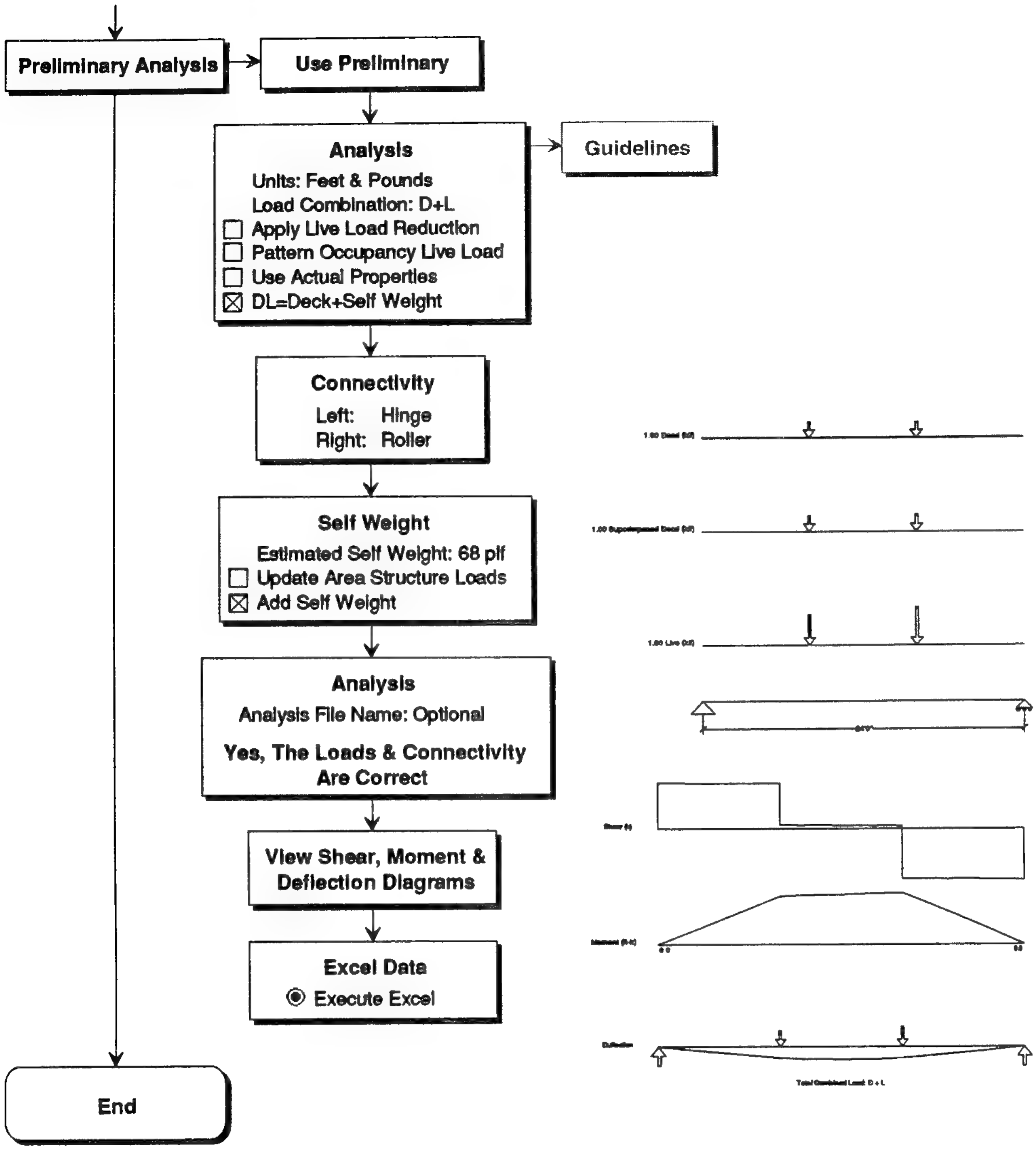
Notes:

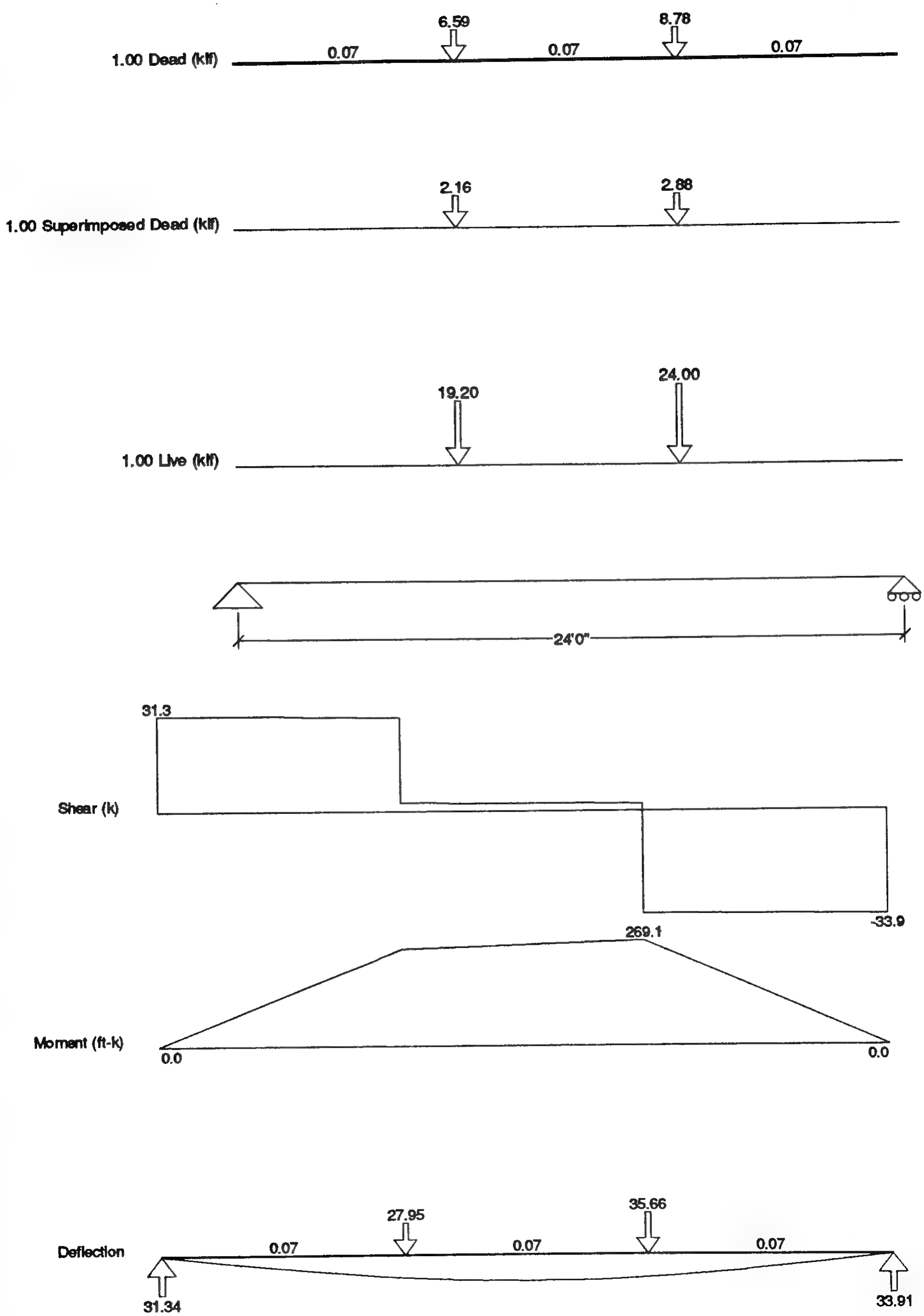
1. Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
2. Dead load shear and moment are not modified with changes in slab depth.

Widely Spaced Element Analysis: Girder



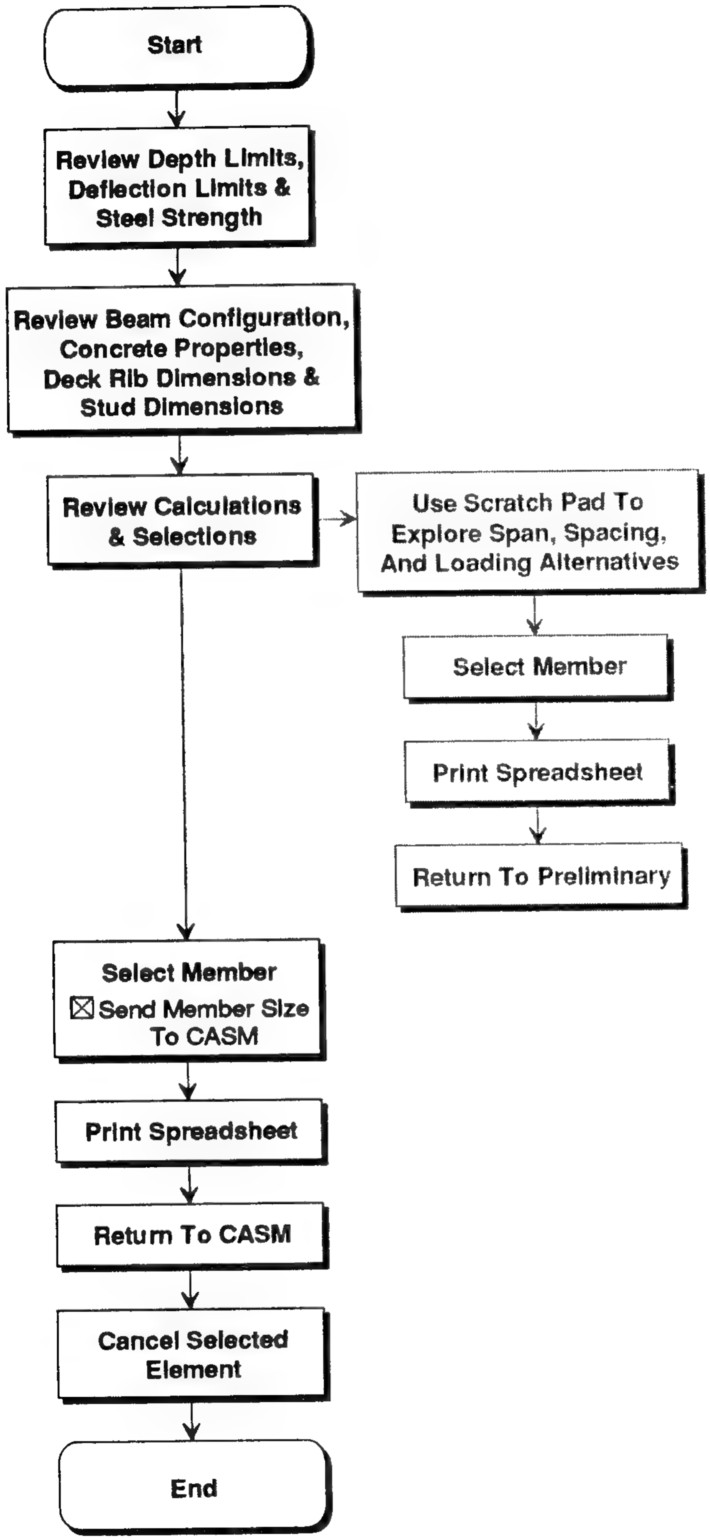



Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L
Apply Live Load Reduction
Pattern Occupancy Live Load
Use Actual Properties
DL=Deck+Self Weight
Guidelines
Connectivity
Left: Hinge
Right: Roller
Self Weight
Estimated Self Weight: 68 plf
Update Area Structure Loads
Add Self Weight
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End



Total Combined Load: D + L

Composite Steel Beam Design



STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Sep 01, 1994
Location: Radford AAP	Engr:

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left)
Roller (Right)
Beam Span: 24.0 ft
Trib Width= 12.0 ft
Depth Limit= 36.0 in. max
Fy= 36.0 ksi
Fb=Fy*0.66= 24.0 ksi
Fy * 0.89= 32.0 ksi
Fv= 14.4 ksi
Es= 29,000 ksi

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		68.8		8.1	8.9
Sup Dead		21.1		2.4	2.6
Live		179.2		20.8	22.4
Lmin Roof					
Snow					
Wind					
Summary		269.1		31.3	33.9

Deflection Limits:

Live Load=	L/360	=0.80 in
Total Load=	L/240	=1.20 in

Reqd Section Properties:

Ss(req)=	57	in^3
Str(req)=	135	in^3
Composite percent=	100	%

Composite Properties:			Spandrel Girder		
f'c=	4.0	ksi	Rib Spacing=	6.00	in
.45f'c=	1.8	ksi	Rib Width=	2.50	in
Wc=	145	pcf	Rib Height=	1.50	in
Ltwt conc coef=	1.0		Studs/rib=	1	
Ec=	3,644	ksi	Stud Diameter=	0.75	in
n=	8.0		Stud Length=	4.0	in
Slab ts=	5.50	in	Reduct. Factor=	1.00	
Slab bE=	36.0	in	Shear Cap=	13.3	kips

CASM Beam Selection Table:

Beam Size	Ss in^3	Dead Ld Defl(in)	Seff in^3	Conc fc (psi)	Steel fs (psi)	Ieff in^4	L + SD Defl(in)	# of Studs	Min % Comp.
W 10 x 77	85.9	-0.53	141.1	1.37	22.88	1,386	-0.51	50	78
W 14 x 61	92.2	-0.38	138.4	1.10	23.33	1,787	-0.39	50	84
W 16 x 57	92.2	-0.32	141.5	0.99	22.81	2,121	-0.33	46	74
W 21 x 50	94.5	-0.25	145.4	0.82	22.20	2,746	-0.26	40	62
W 12 x 72	97.4	-0.41	148.7	1.16	21.72	1,678	-0.42	50	52

CASM Steel Beam Selection:

				Live Ld	Total
W 21 x 50	Span= 24.0 ft	Seff(in3)= 145.4	Ieff(in4)= 2,746	Defl(in)= -0.26	-0.50
Shores Reqd: No	Nstuds= 40 (full)	Partial: (100 %)	Nstuds= 40	fv=	4.3ksi
			Beam Wgt=	0.60	tons

Notes:

1. Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
2. Dead load shear and moment are not modified with changes in slab depth.

Column Load Run Down

Start

Use Loads & Design Tool Palette

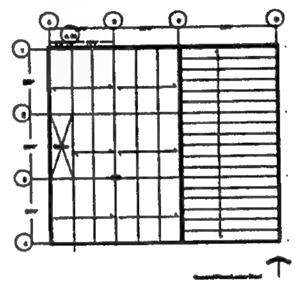
Material Steel

Live Load Reduction → Occupancy (LL) ☒ Apply Live Load Reduction

Select Element To Analyze & Design → Column Rolled Section

Select Column B3

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads → Use Compare Min. Roof LL & Snow Loads

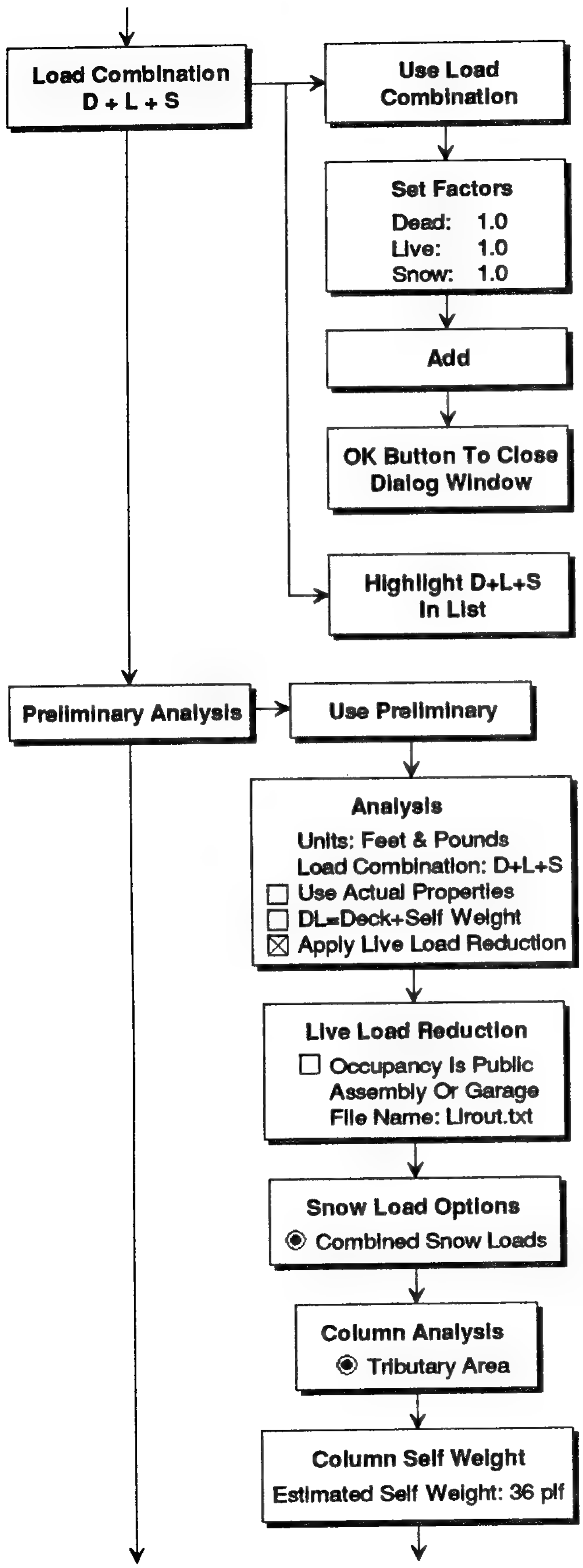
Analysis
Units: Feet & Pounds

Snow Load Options
◉ Combined Snow Loads

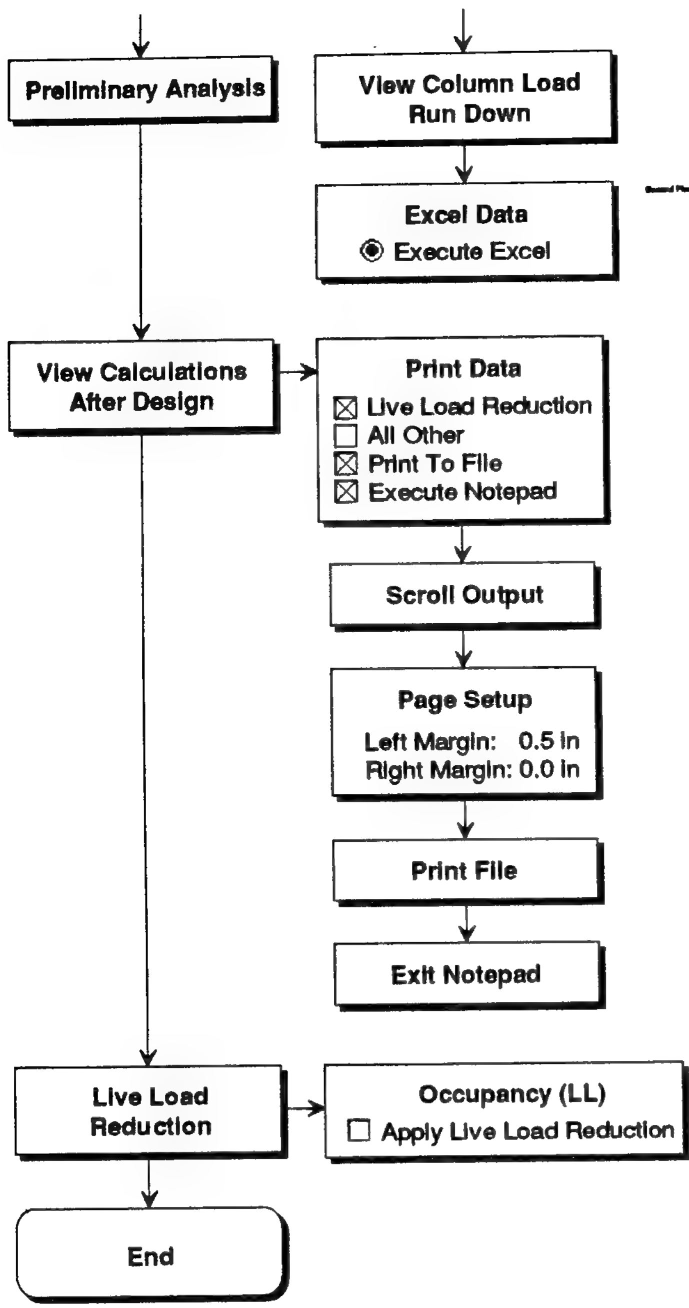
Minimum Roof (LL)

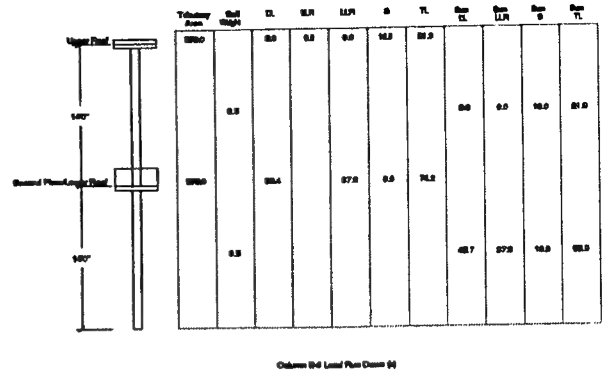
Column Analysis
◉ Tributary Area

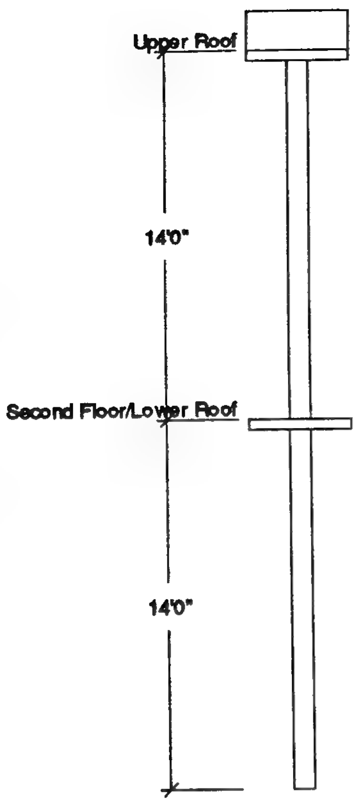
Compare Min. Roof LL & Snow Loads



Load Combination D + L + S
Use Load Combination
Set Factors
Dead: 1.0
Live: 1.0
Snow: 1.0
Add
OK Button To Close Dialog Window
Highlight D+L+S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L+S
Use Actual Properties
DL=Deck+Self Weight
Apply Live Load Reduction
Live Load Reduction
Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Snow Load Options
Combined Snow Loads
Column Analysis
Tributary Area
Column Self Weight
Estimated Self Weight: 36 plf


Preliminary Analysis
View Column Load Run Down
Excel Data
Execute Excel
View Calculations After Design
Print Data
Live Load Reduction
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Live Load Reduction
Occupancy (LL)
Apply Live Load Reduction
End





Tributary Area	Lr	S	Sum Lr	Sum S
576.0	7.2	13.0		
			7.2	13.0
576.0	0.0	0.0		
			7.2	13.0

Column B-3 Load Run Down (k)

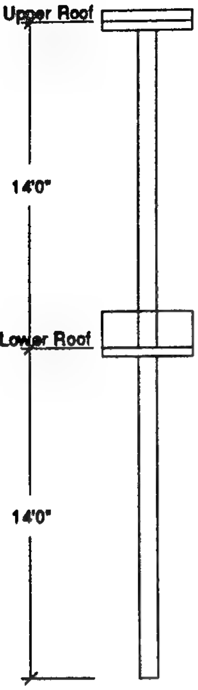
```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Thu Sep 01, 1994  10:36 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 576.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
200 < At < 600   R1 = 1.2-0.001*At
                 R1 = 0.624
F <= 4           R2 = 1.00
Lr = 12.48 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 12.48 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



	Tributary Area	Self Weight	DL	LLR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
Upper Roof	576.0		8.3	0.0	0.0	13.0	21.3				
14'0"		0.5						8.8	0.0	13.0	21.8
Second Floor/Lower Roof	576.0		35.0		37.8	0.0	72.8				
14'0"		0.5						44.3	37.8	13.0	95.1

Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Thu Sep 01, 1994  10:40 AM

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Office: Offices (Lo) :   50.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+--------------------------+
|     L = 28.13 psf        |
+--------------------------+
```

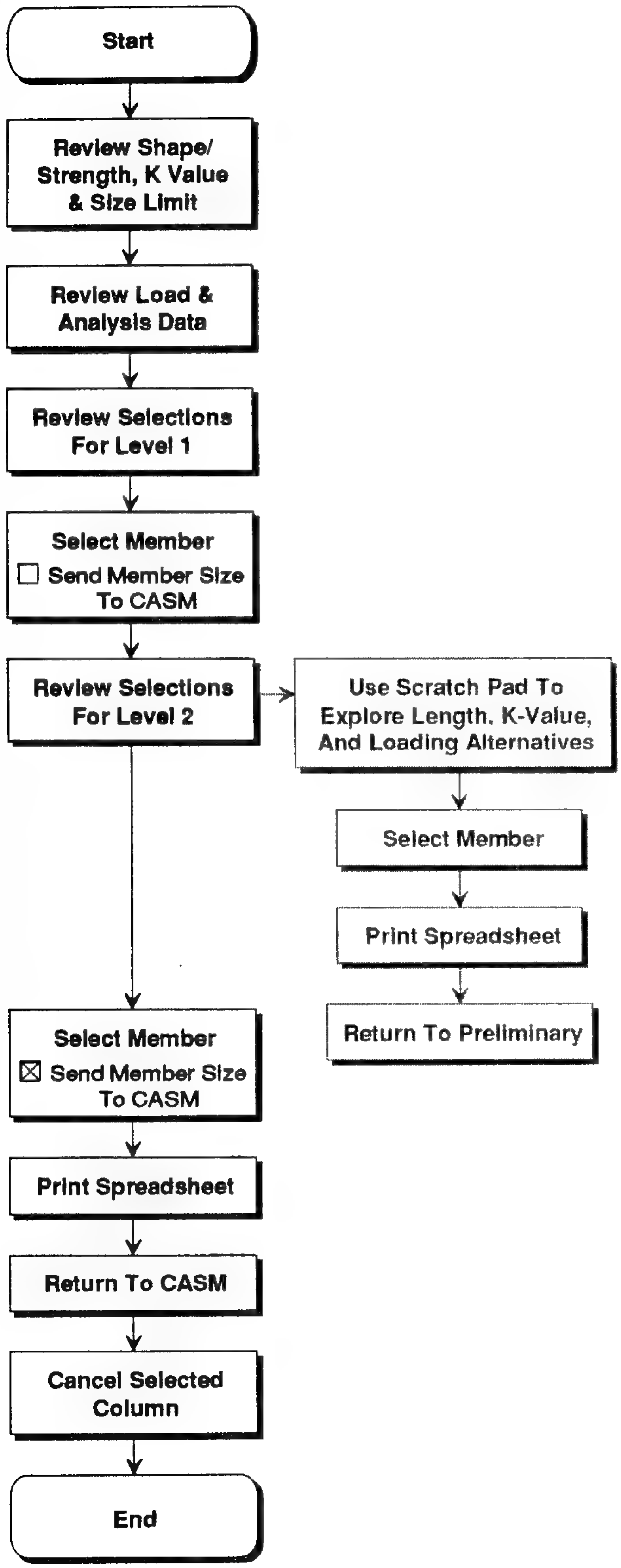
```
**************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Corridor: Main (Lo) :  100.0 psf
Tributary area (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 56.3 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 50.0 psf
+------------------------+
|     L = 56.25 psf      |
+------------------------+

**************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Files & Storage (Lo) :  150.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo > 100.0 psf
Member supports only one floor.
No live load reduction taken.
L = Lo
+------------------------+
|     L = 150.00 psf     |
+------------------------+
```

Steel Column Design



STEEL COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme B Location: Radford AAP	Date: Sep 01, 1994 Engr:

CASM Load & Analysis Data:

Method: Analysis   Load Combination: D + L + S   Steel Fy= 36.0 ksi
Member ID: B-3   Size Limit= 10.0 in. max   E= 29000 ksi

Name	Level	Flr to Flr Ht	Trib Area	Floor Level Load Totals (kips) Dead	Live	Lmin	Snow	Wind	Load Totals
	6								
	5								
	4								
	3								
Upper Roof	2	14.0	576	8.8			13.0		21.8
Second Floor/L	1	14.0	576	44.3	37.8		13.0		95.1

CASM Column Selection Table

Level: 2   Preq: 21.76 kips   K-value: 1.0   Cc= 126.1
Col Shape: W   Length: 14.0 ft   kl: 14.0

Column Size	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	fa (ksi)	Pallow (kip)	Weight (ton)
W 6 x 15	5.99	5.99	4.43	1.46	115.07	10.98	4.91	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.65	39.6	0.11
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	3.93	47.7	0.13
W 6 x 20	6.20	6.02	5.87	1.50	112.00	11.40	3.71	66.9	0.14
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.64	103.2	0.20

CASM Steel Column Selection

Column Size	Level	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	Pallow (kip)	Weight (ton)
W 8 x 28	2	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
W 8 x 28	1	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20

Total Column Weight: 0.39

Notes:

1. Steel column properties from ASD - AISC Steel Construction Manual, 9th edition

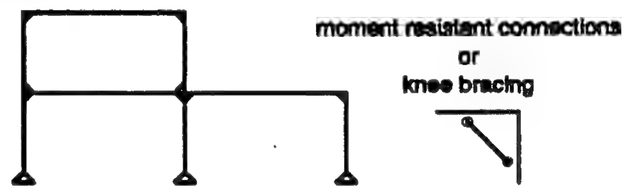
Lateral Resistance Philosophy

Steps Required

1. Create building volume
2. Define a structural grid
3. Layout structural framing on ALL levels
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads
5. Select a load combination including wind or seismic loads
6. Define N-S & E-W vertical resistance system

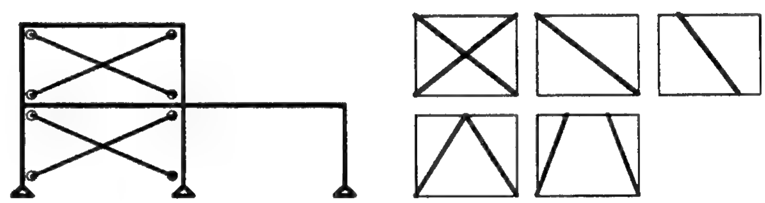
   Options:

   1. Unbraced Frames

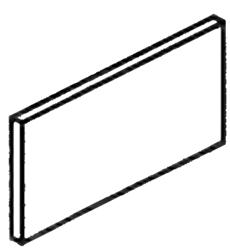


   2. Braced Frames

      A. Trussing



      B. Shear Walls



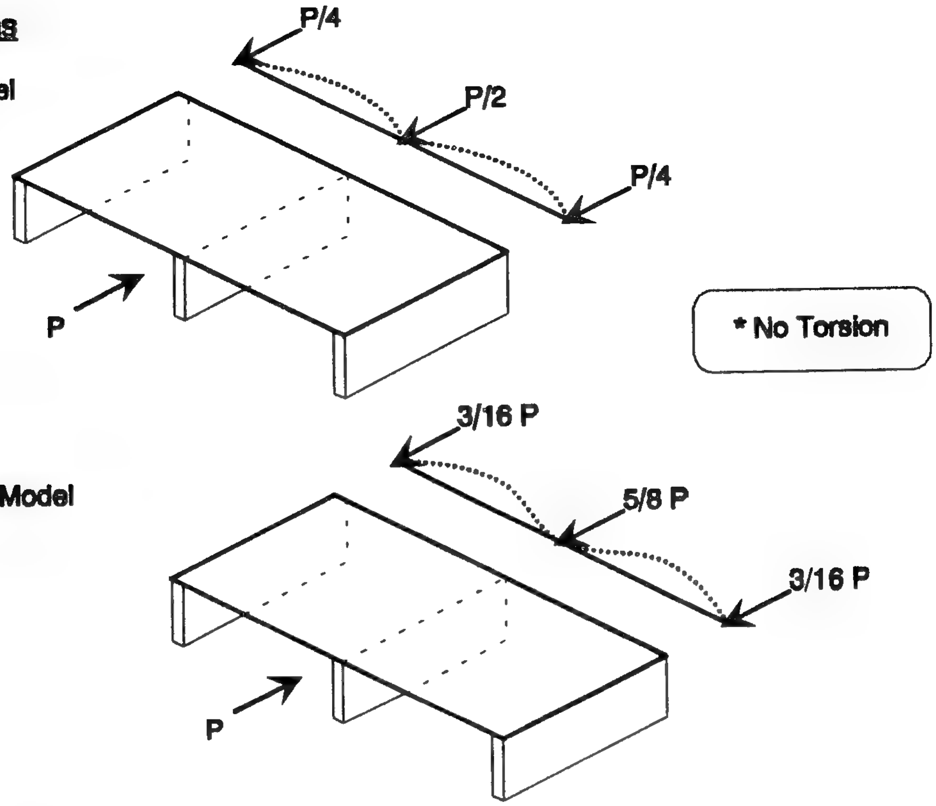
7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

Flexible Diaphragms

Simple Beam Model
(tributary area)

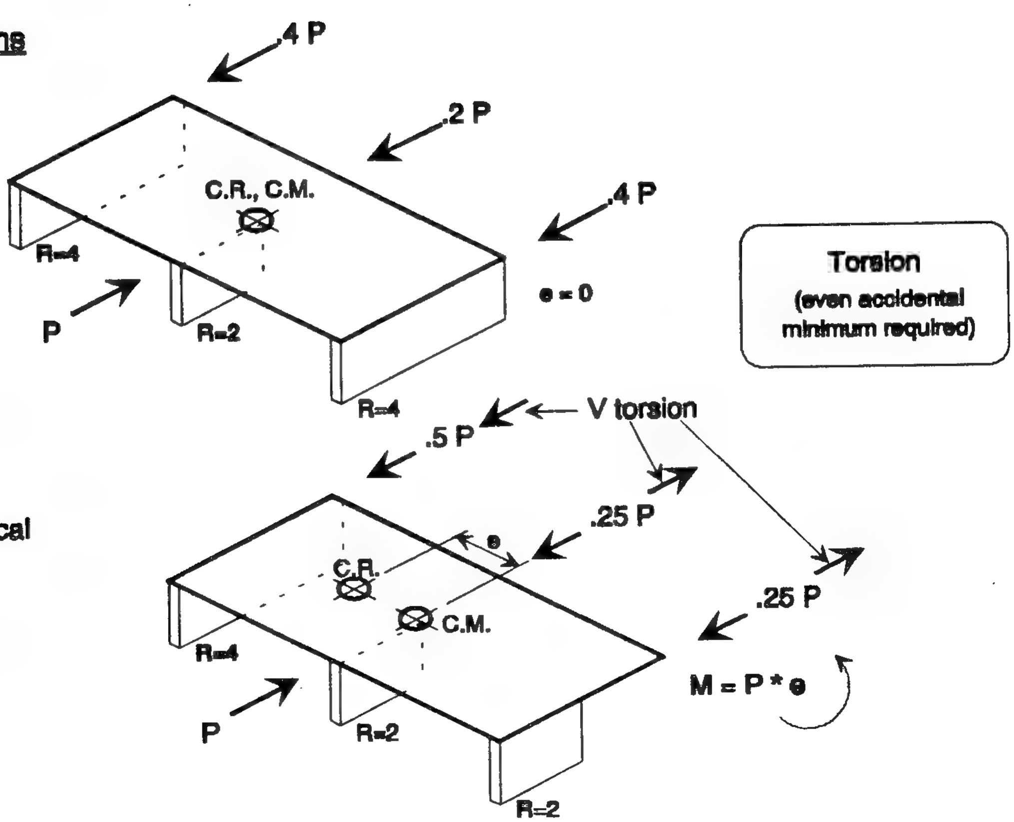
Continuous Beam Model



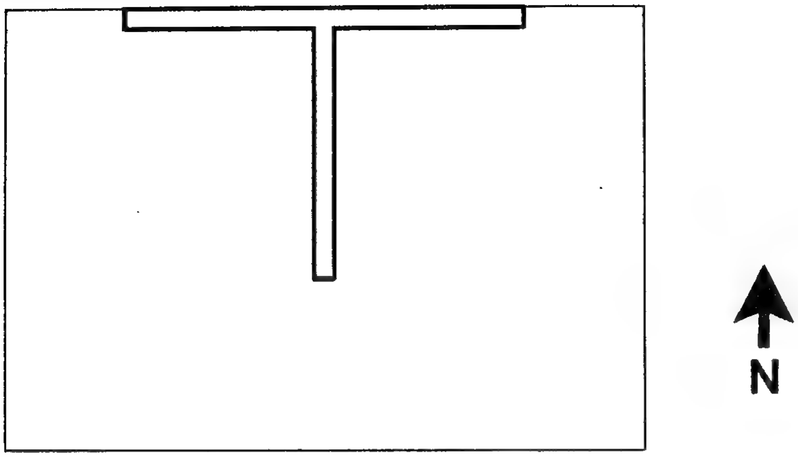
Rigid Diaphragms

Symmetrical

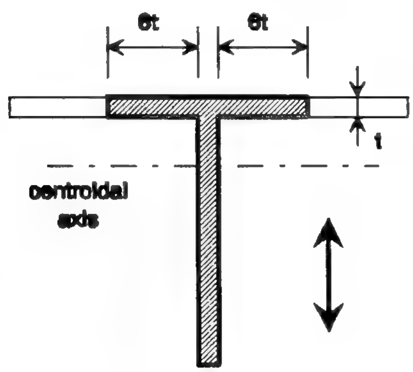
Non-Symmetrical



Monolithic Perpendicular Shear Walls



For N-S



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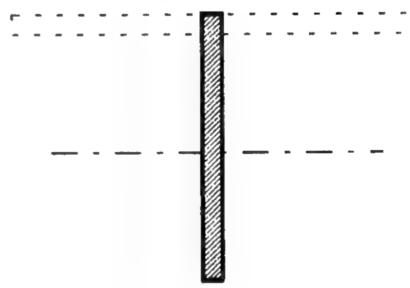
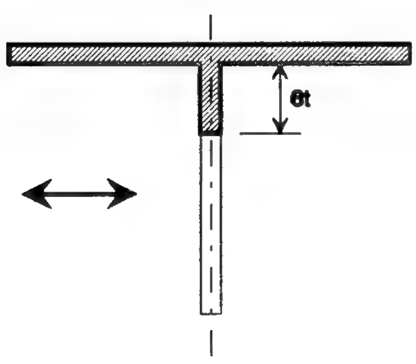
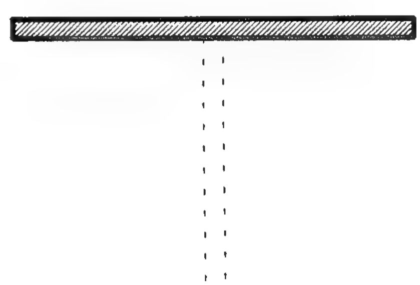


For E-W



or



Define Lateral Resistance

Start

Use Draw Structure Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Define Second Floor/ Lower Roof Diaphragm Type

Diaphragm Guidlines

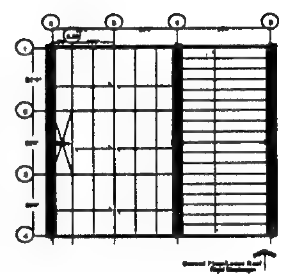
Lateral Horizontal Rigid Diaphragm

Define N-S Lateral Resistance

Define Location

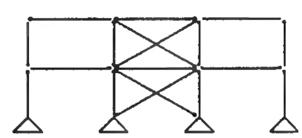
Vertical Define Location

Select Beam On Grid Line A



Define Bracing & Connectivity

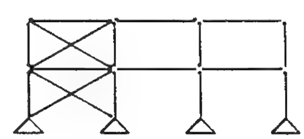
Vertical Define Elements



NS-1

Select NS-1

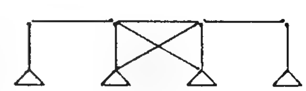
Define X-Bracing



NS-2

Select Bays

Double Click Right Mouse Key To End



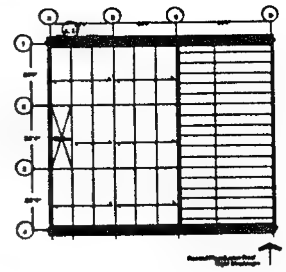
NS-3

Close Lateral Resistance Dialog Window

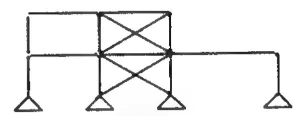
Repeat For Grid Lines C & D

Define E-W Lateral Resistance

- **Define Location**
  - Vertical Define Location
  - Select Beam On Grid Line 1



- **Define Bracing & Connectivity**
  - Vertical Define Elements
  - Select EW-1
  - Define X-Bracing
  - Select Bays
  - Double Click Right Mouse Key To End
  - Close Lateral Resistance Dialog Window



EW-1 & EW-2

- **Repeat For Grid Line 4**

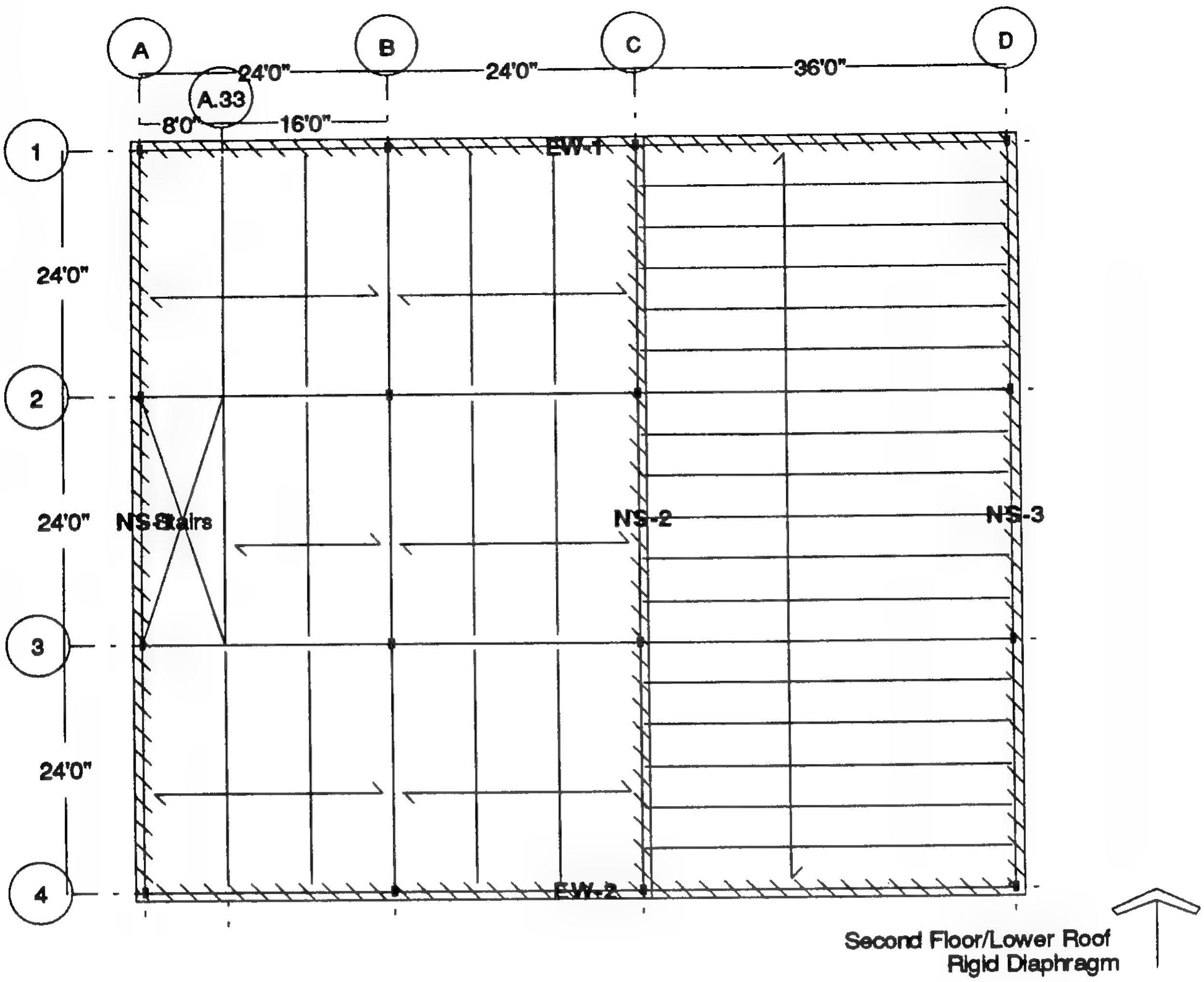
Define Upper Roof Diaphragm Type

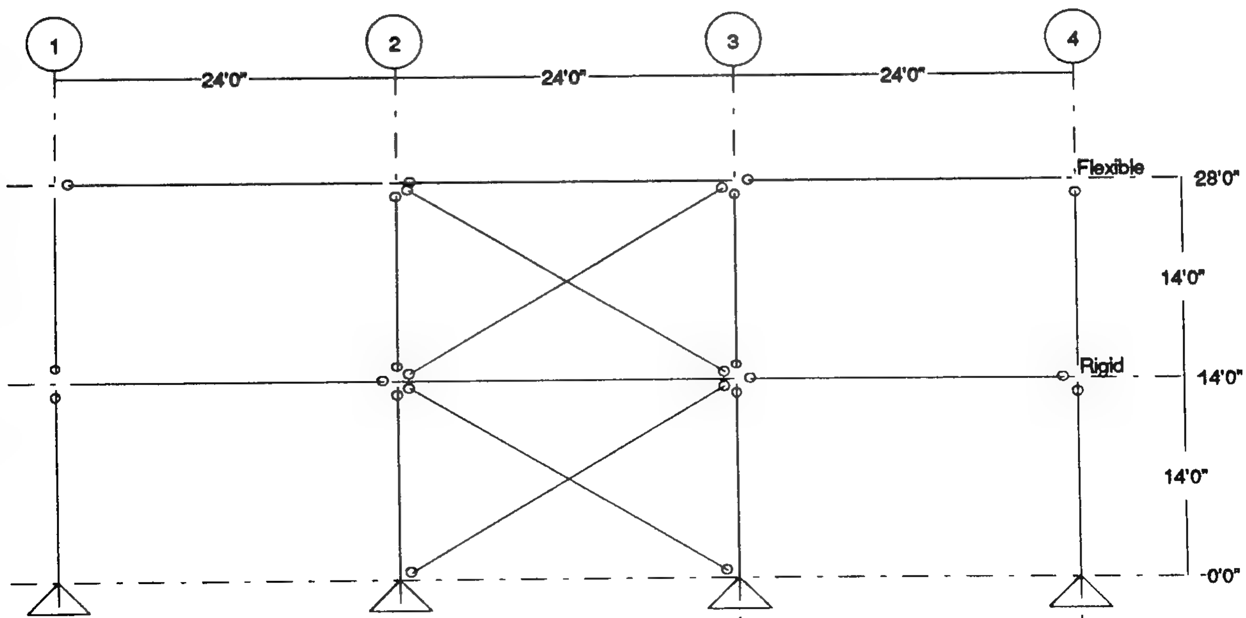
- Select Upper Roof Horizontal Structural Plane
- Lateral Horizontal Flexible Diaphragm

Display Lateral Resistance Locations

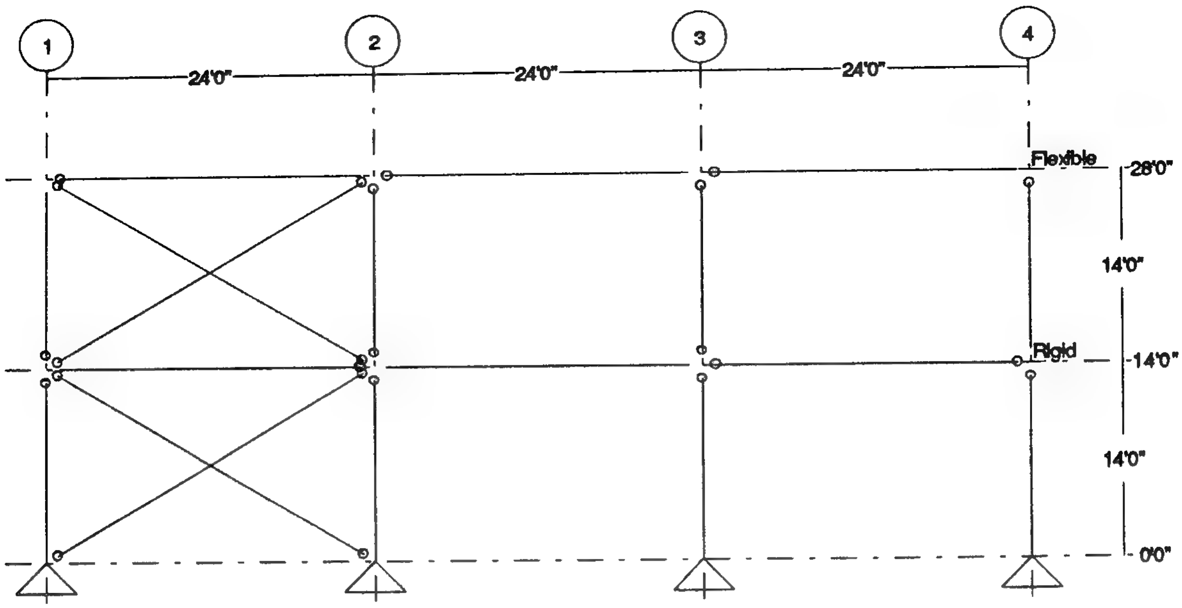
- Show Structure
  - ☒ NS Lateral Resistance
  - ☐ EW Lateral Resistance

End

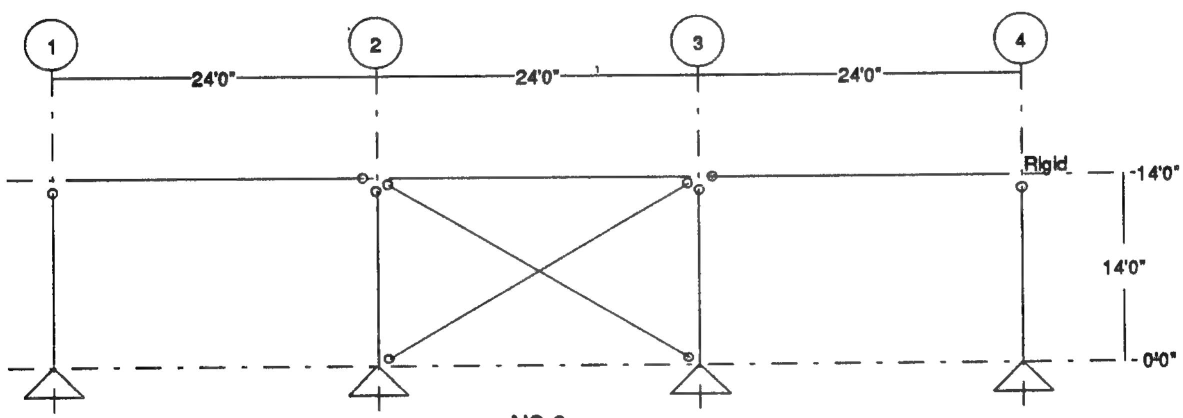

A
B
C
D
A.33
24'0"
24'0"
36'0"
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
EW-1
EW-2
NS-1
Stairs
NS-2
NS-3
Second Floor/Lower Roof
Rigid Diaphragm


1
2
3
4
24'0"
24'0"
24'0"
Flexible
28'0"
14'0"
Rigid
14'0"
14'0"
0'0"

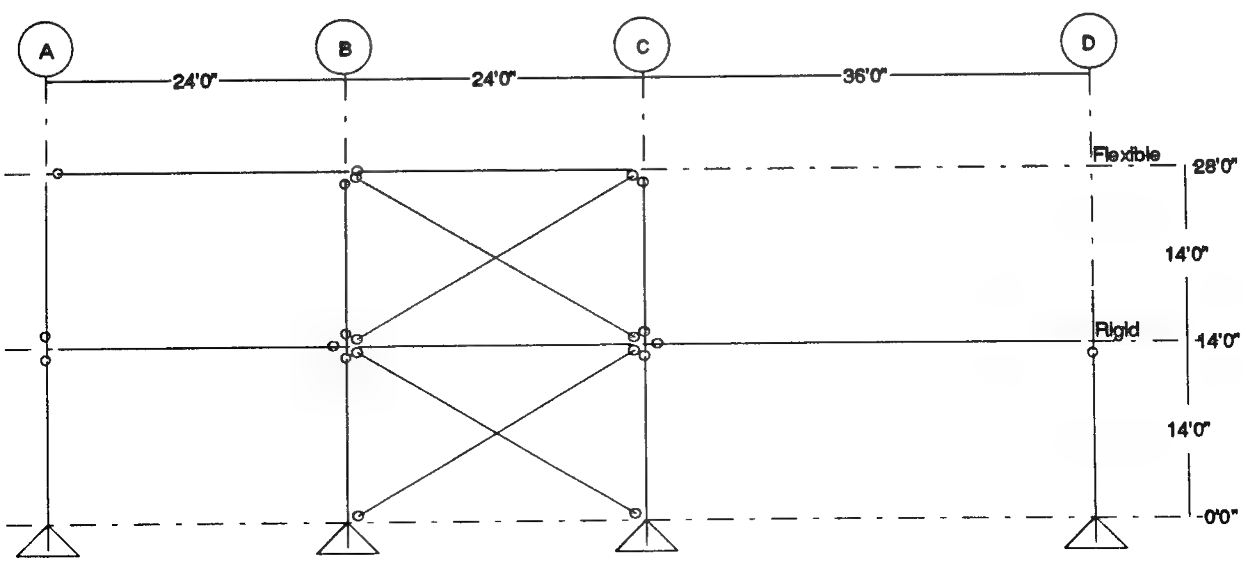
NS-1



NS-2

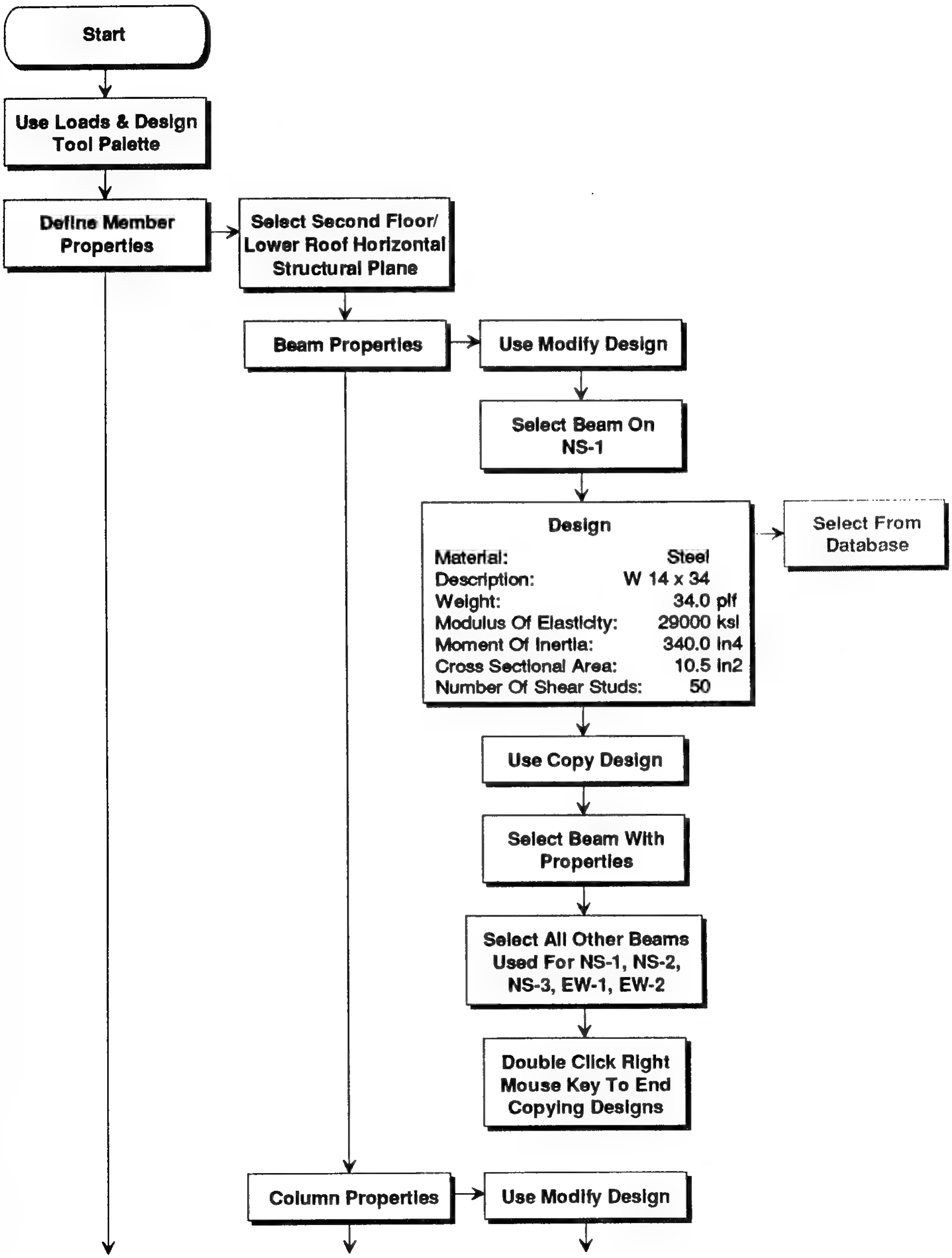


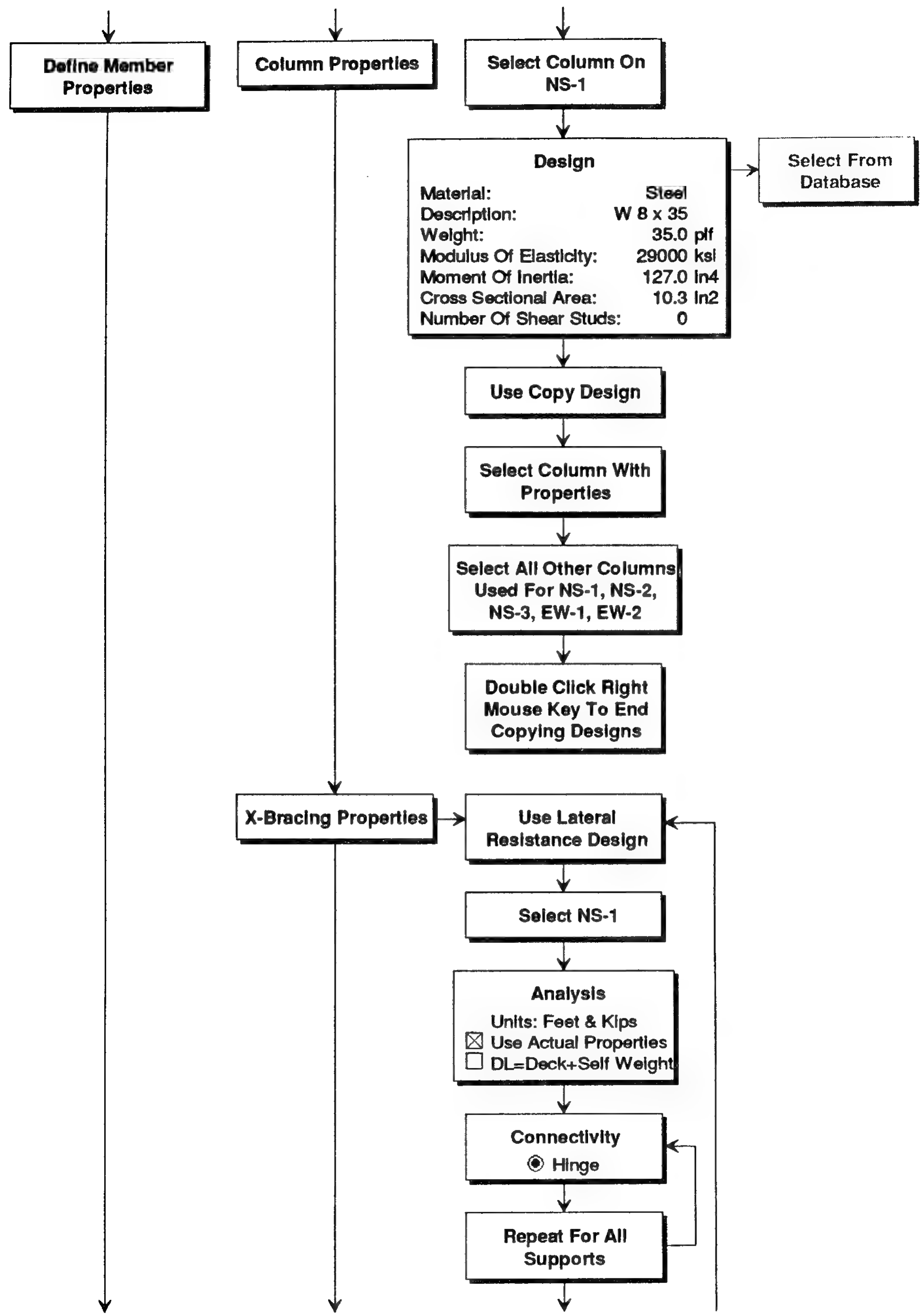
NS-3



EW-1 & EW-2

Wind Lateral Analysis




Define Member Properties
Column Properties
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 35
Weight: 35.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 127.0 in4
Cross Sectional Area: 10.3 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, NS-3, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
X-Bracing Properties
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Hinge
Repeat For All Supports

Define Member Properties

X-Bracing Properties

Lateral Resistance Verify X-Bracing

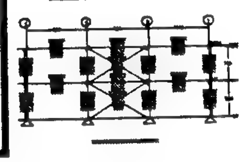
Modify Properties

Select X-Bracing

Design

Material:	Steel
Description:	TS 3x3x1/4
Weight:	8.81 plf
Modulus Of Elasticity:	29000 ksi
Moment Of Inertia:	3.16 in4
Cross Sectional Area:	2.59 in2

Select From Database



No, To Stop Analysis

Repeat For NS-2, NS-3, EW-1, EW-2

Select Upper Roof Horizontal Structural Plane

Beam Properties

Use Modify Design

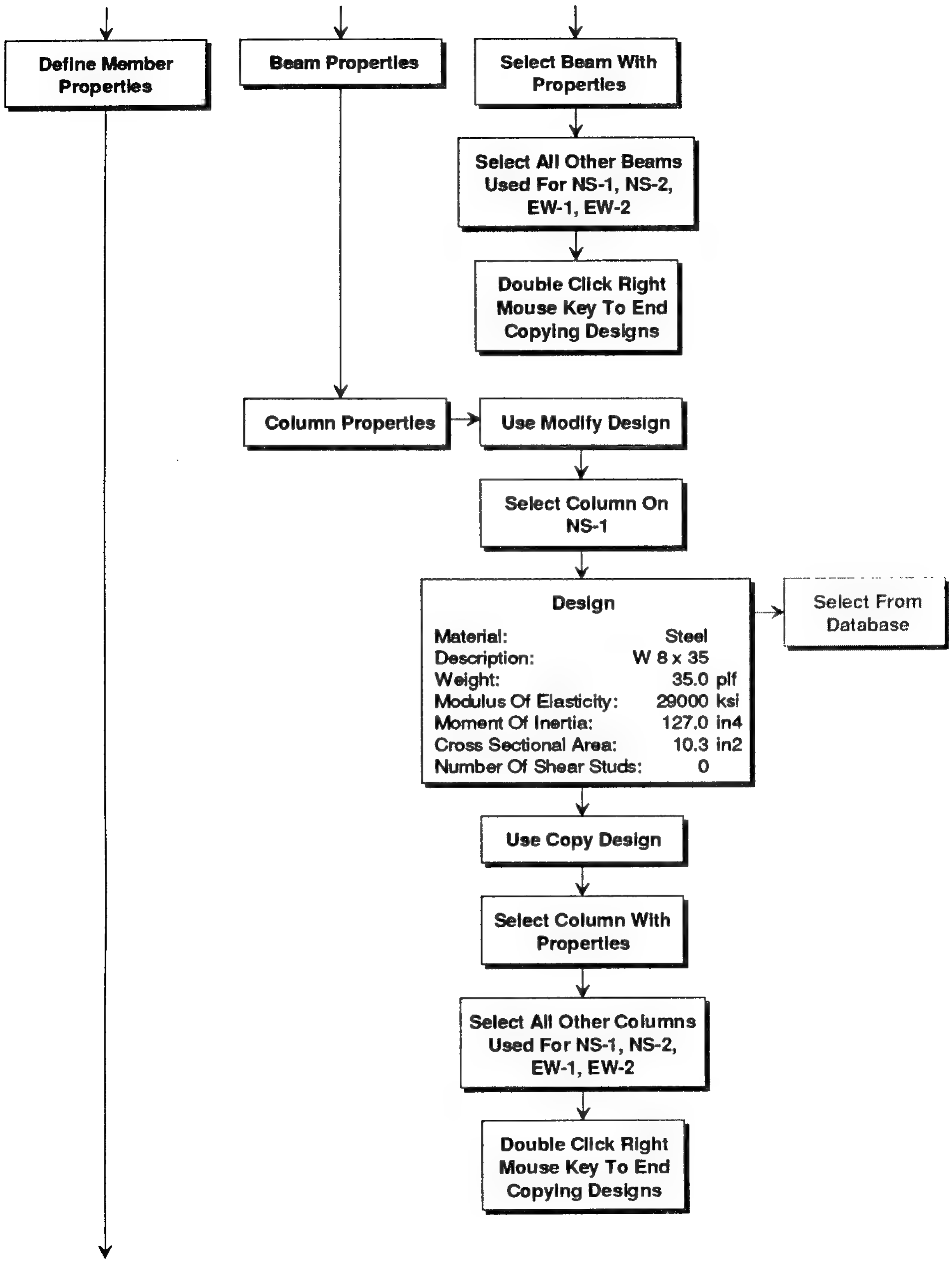
Select Beam On NS-1

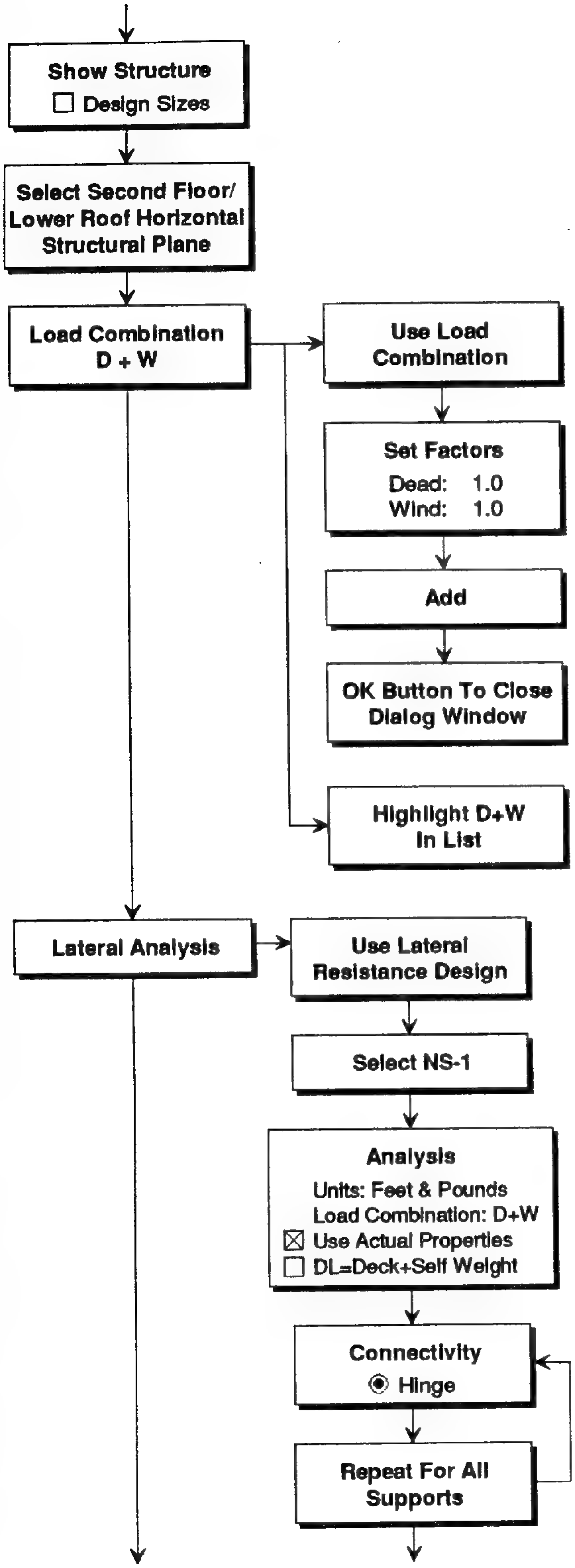
Design

Material:	Steel
Description:	W 12 x 22
Weight:	22.0 plf
Modulus Of Elasticity:	29000 ksi
Moment Of Inertia:	156.0 in4
Cross Sectional Area:	6.48 in2
Number Of Shear Studs:	0

Select From Database

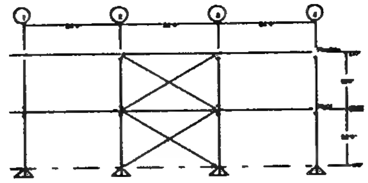
Use Copy Design


Define Member Properties
Beam Properties
Select Beam With Properties
Select All Other Beams Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Column Properties
Use Modify Design
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 35
Weight: 35.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 127.0 in4
Cross Sectional Area: 10.3 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs

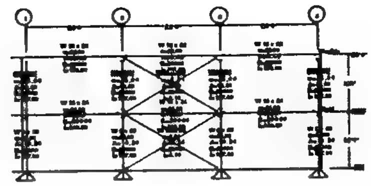

Show Structure
Design Sizes
Select Second Floor/ Lower Roof Horizontal Structural Plane
Load Combination D + W
Use Load Combination
Set Factors
Dead: 1.0
Wind: 1.0
Add
OK Button To Close Dialog Window
Highlight D+W In List
Lateral Analysis
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Pounds
Load Combination: D+W
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Hinge
Repeat For All Supports

Lateral Analysis

Lateral Resistance
Verify X-Bracing



Yes, Properties
Are All Correct

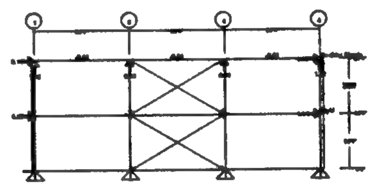


Wind Load Options
Wind Direction: South
When 2 Wind Loads: Max. Suction
Wind Load: GCpi = 0

Flexible Diaphragm
◉ Simple Beam Model

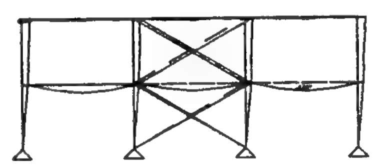
Rigid Horizontal Diaphragm
Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level

View Loads



Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity
Are Correct

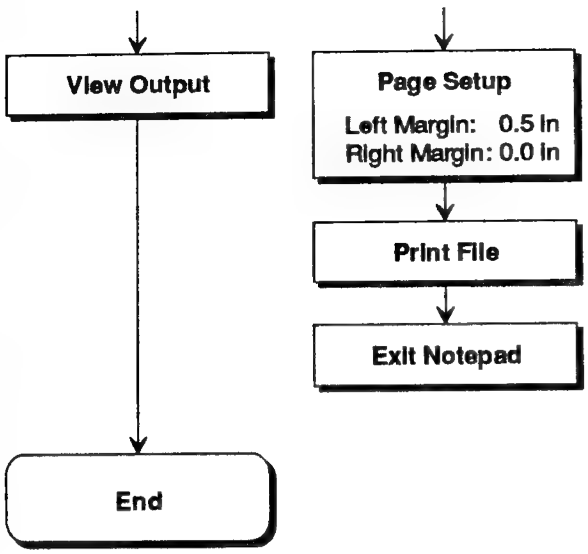
View Shear, Moment, Deflection
& Reaction Diagrams

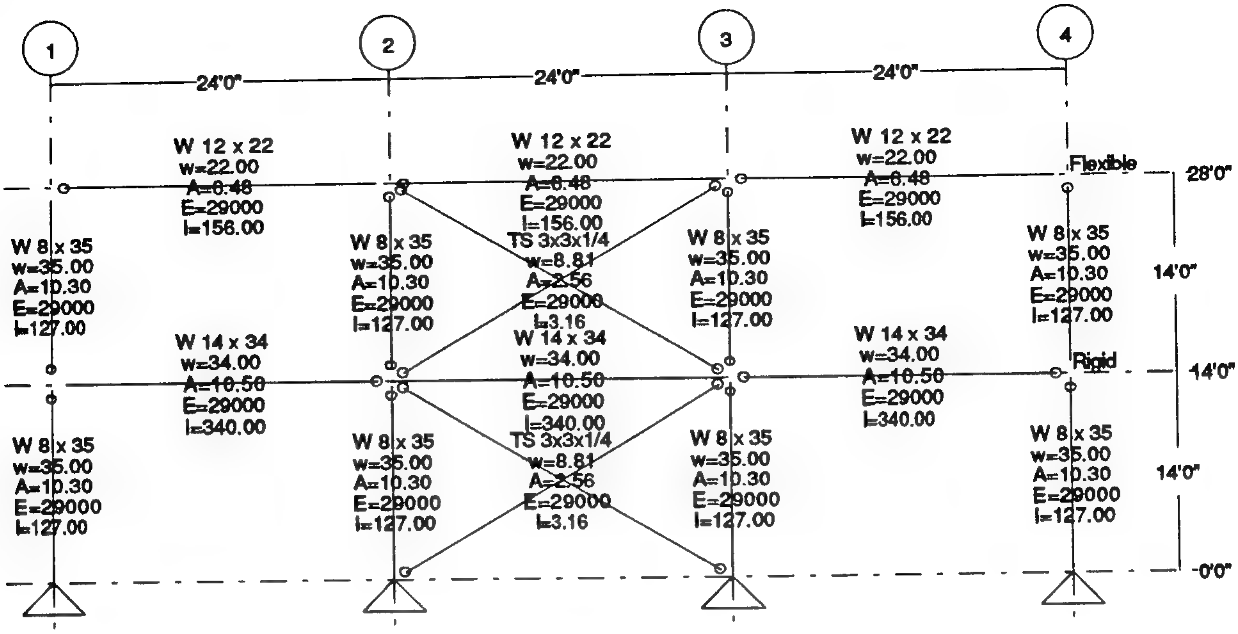


View Output

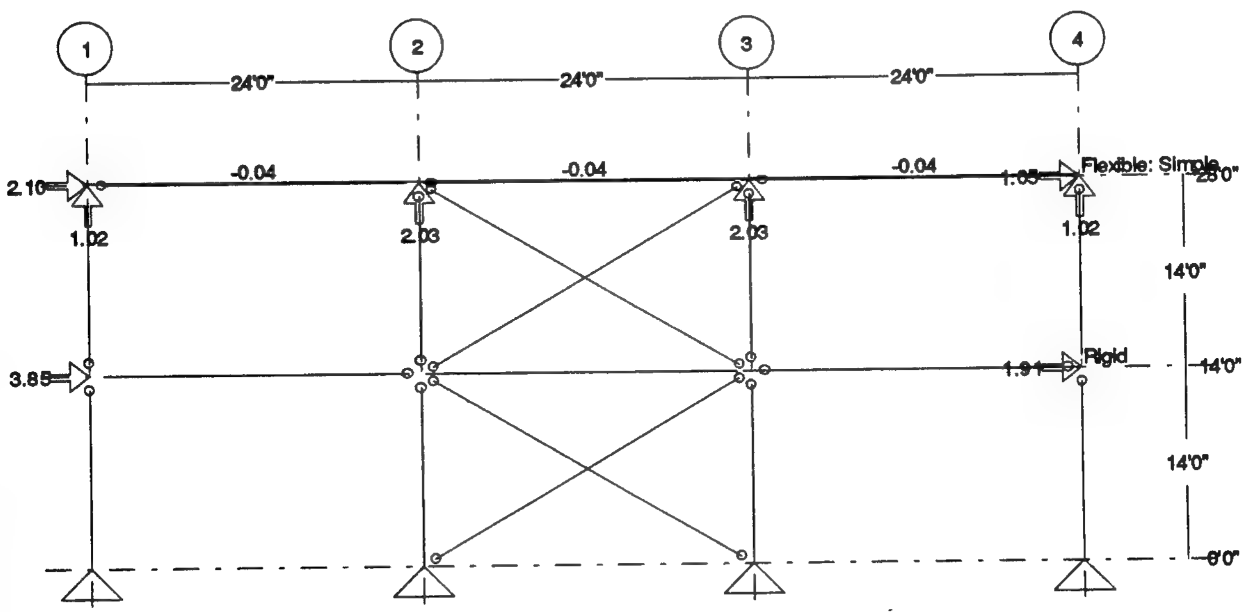
Print Data
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad

Scroll Output

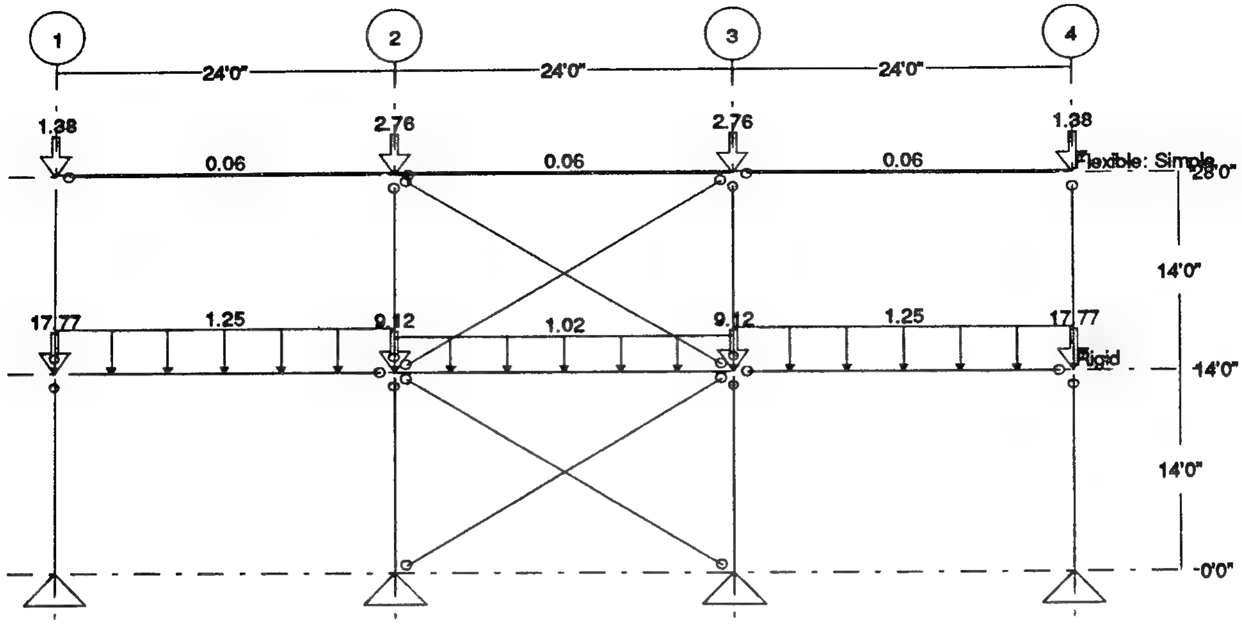

View Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



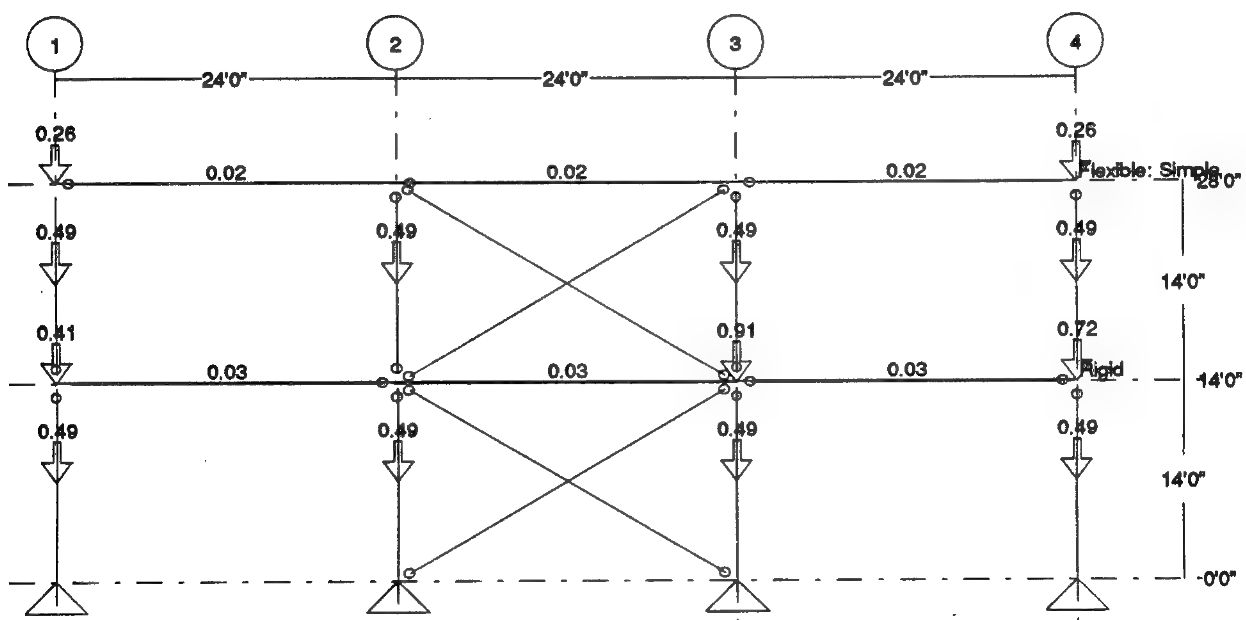
Properties: w (plf), A (in2), E (ksi), I (in4)



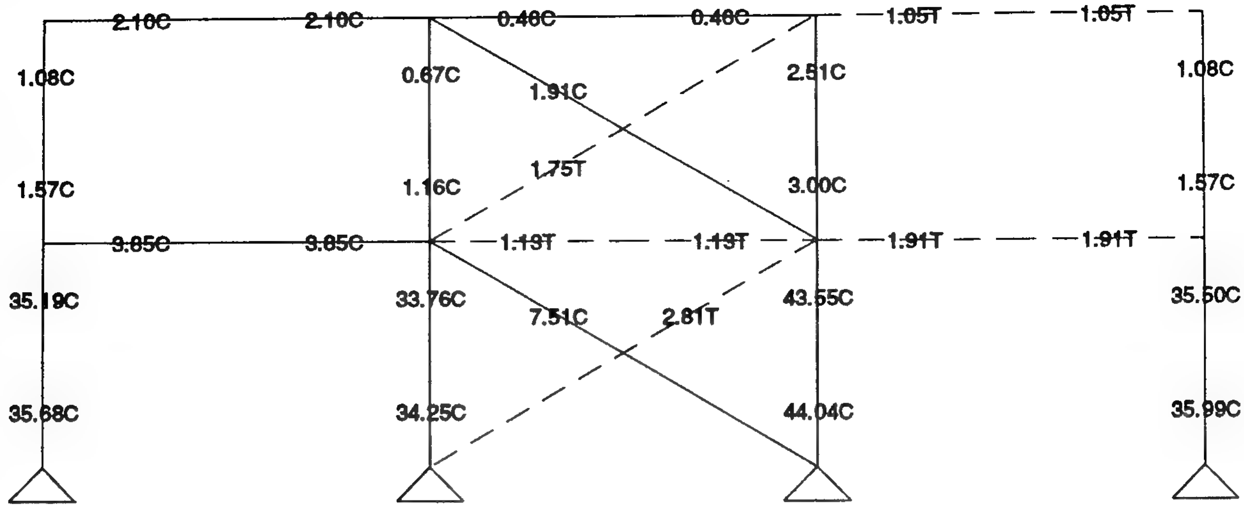
1.00 Wind (klf) – NS-1 – F, 36%



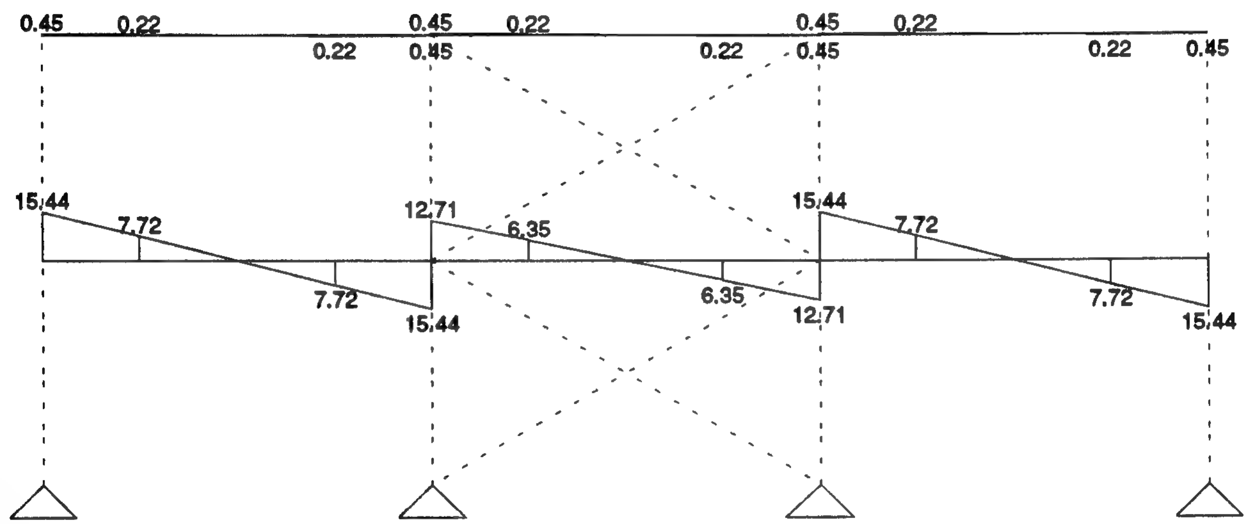
1.00 Superimposed Dead (klf) -- NS-1



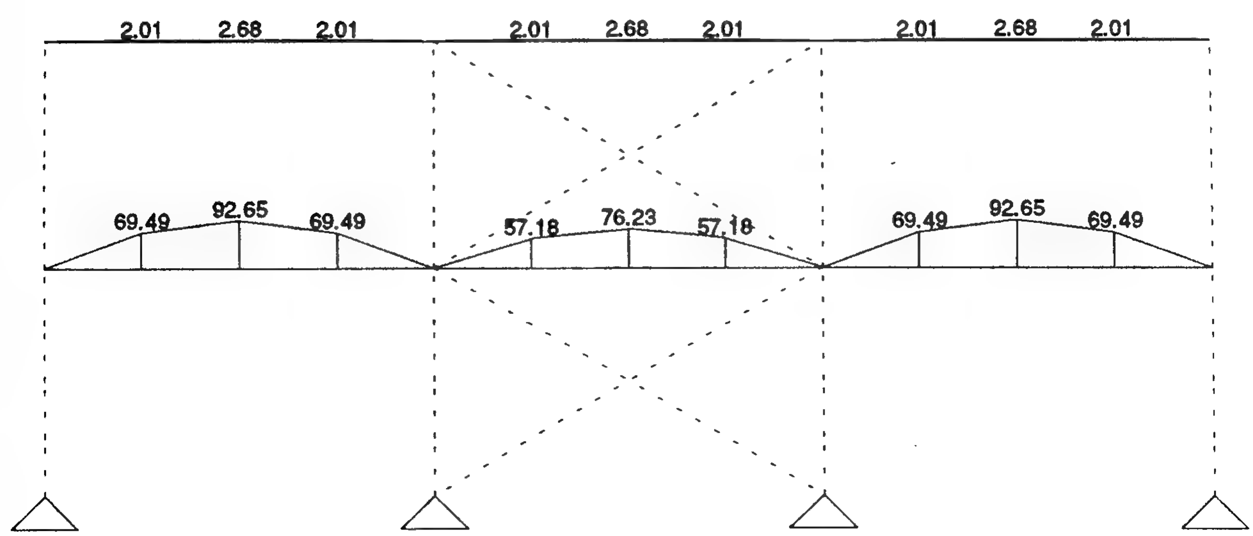
1.00 Dead (klf) -- NS-1



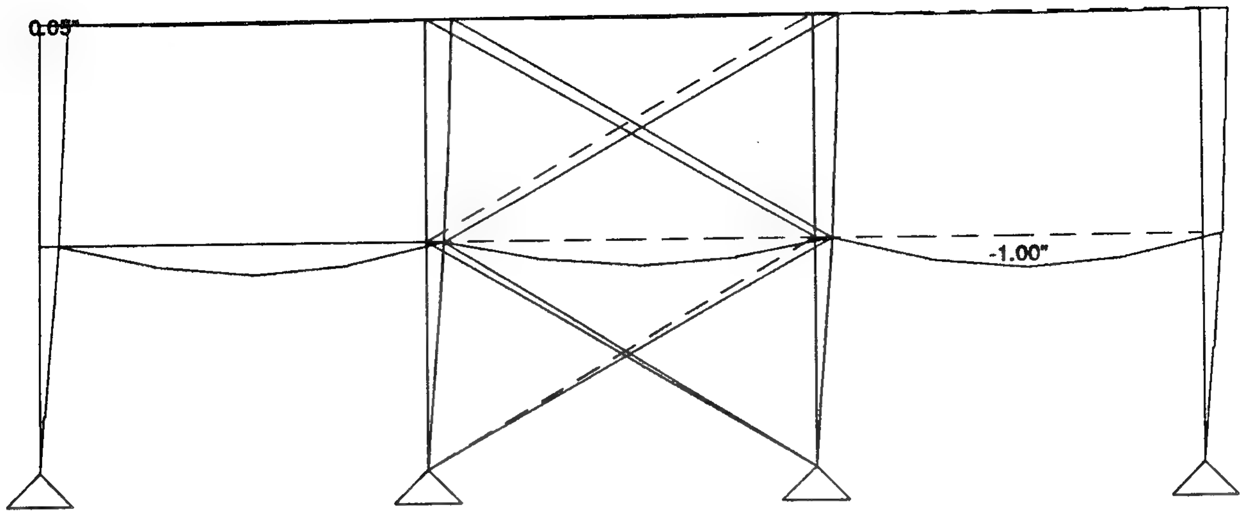
Total Combined Load: D + W -- Axial (k)



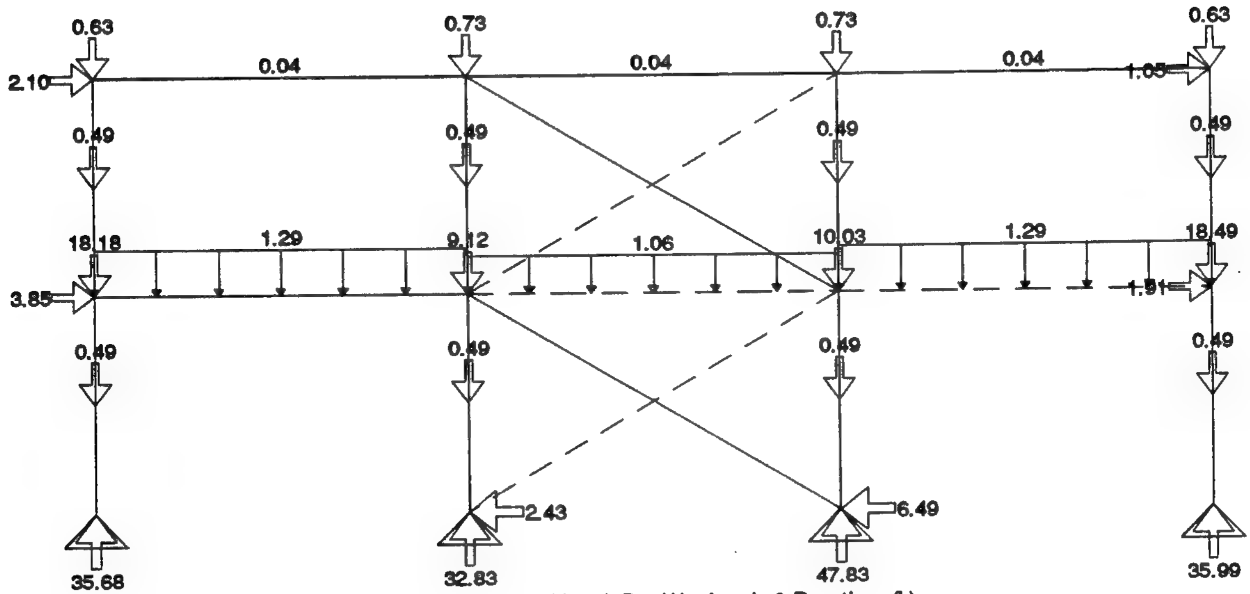
Total Combined Load: D + W -- Shear (k)



Total Combined Load: D + W -- Moment (ft-k)



Total Combined Load: D + W -- Deflection



Total Combined Load: D + W -- Loads & Reactions (k)

Project : Office Building - Scheme B
Location : Radford AAP
Time : Thu Sep 01, 1994 11:17 AM

***************** Rigid Horizontal Diaphragm Calculations *****************

Center of Rigidity

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
NS-1	14.0	0	0	3.274	0.305	35.92%	0.8	0.255
NS-2	14.0	0	0	3.239	0.309	36.31%	48.8	15.077
NS-3	14.0	0	0	4.236	0.236	27.77%	84.8	20.027
Sum					0.850			35.359

Centroid from lower left = sum(R*x)/sum(R) : 41.59 ft
Maximum rigid diaphragm dimension : 85.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 1.25 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	14.0	0	0	3.239	0.309	50.00%	72.8	22.487
EW-2	14.0	0	0	3.239	0.309	50.00%	0.8	0.257
Sum					0.617			22.744

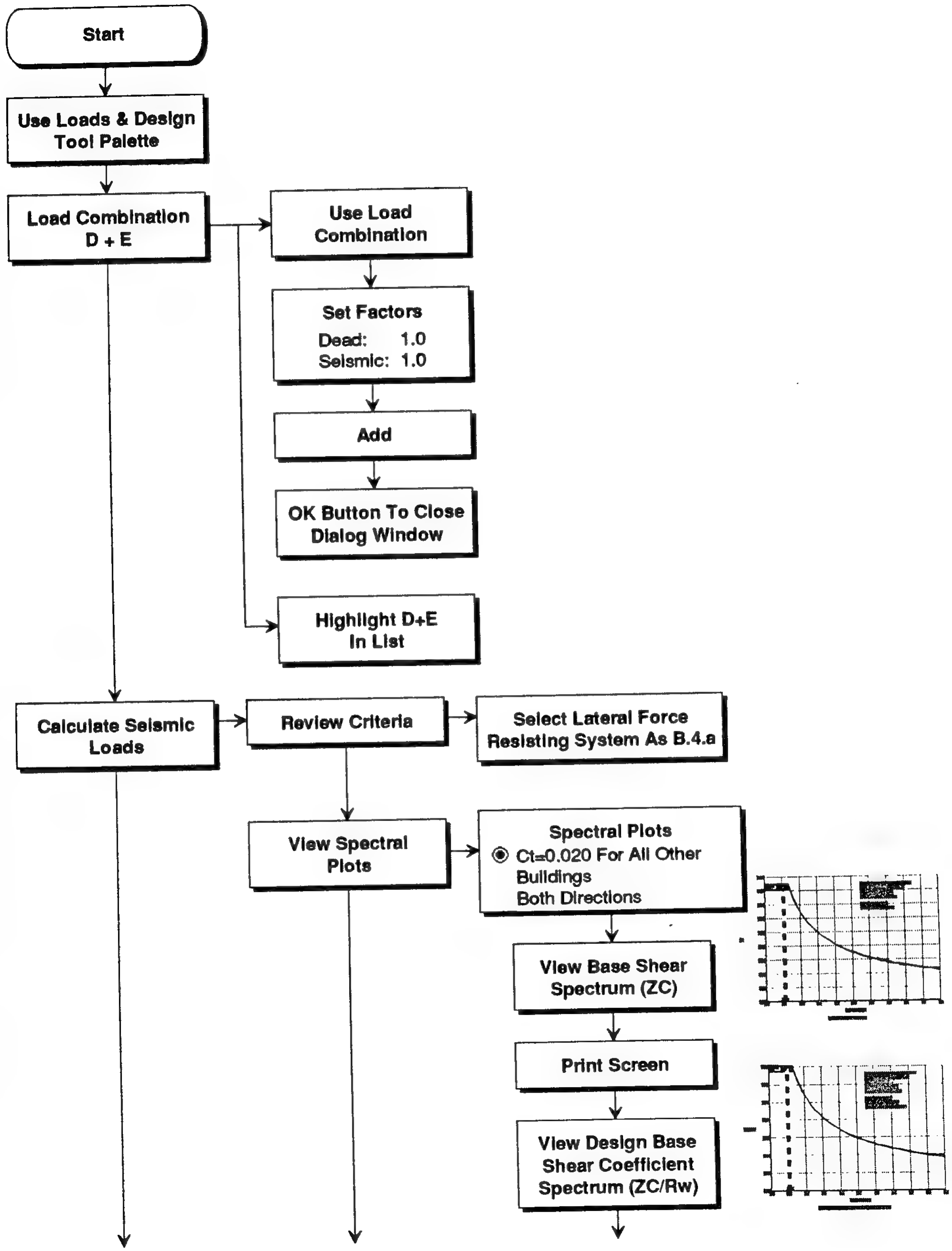
Centroid from lower left = sum(R*x)/sum(R) : 36.83 ft
Maximum rigid diaphragm dimension : 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 0.00 ft

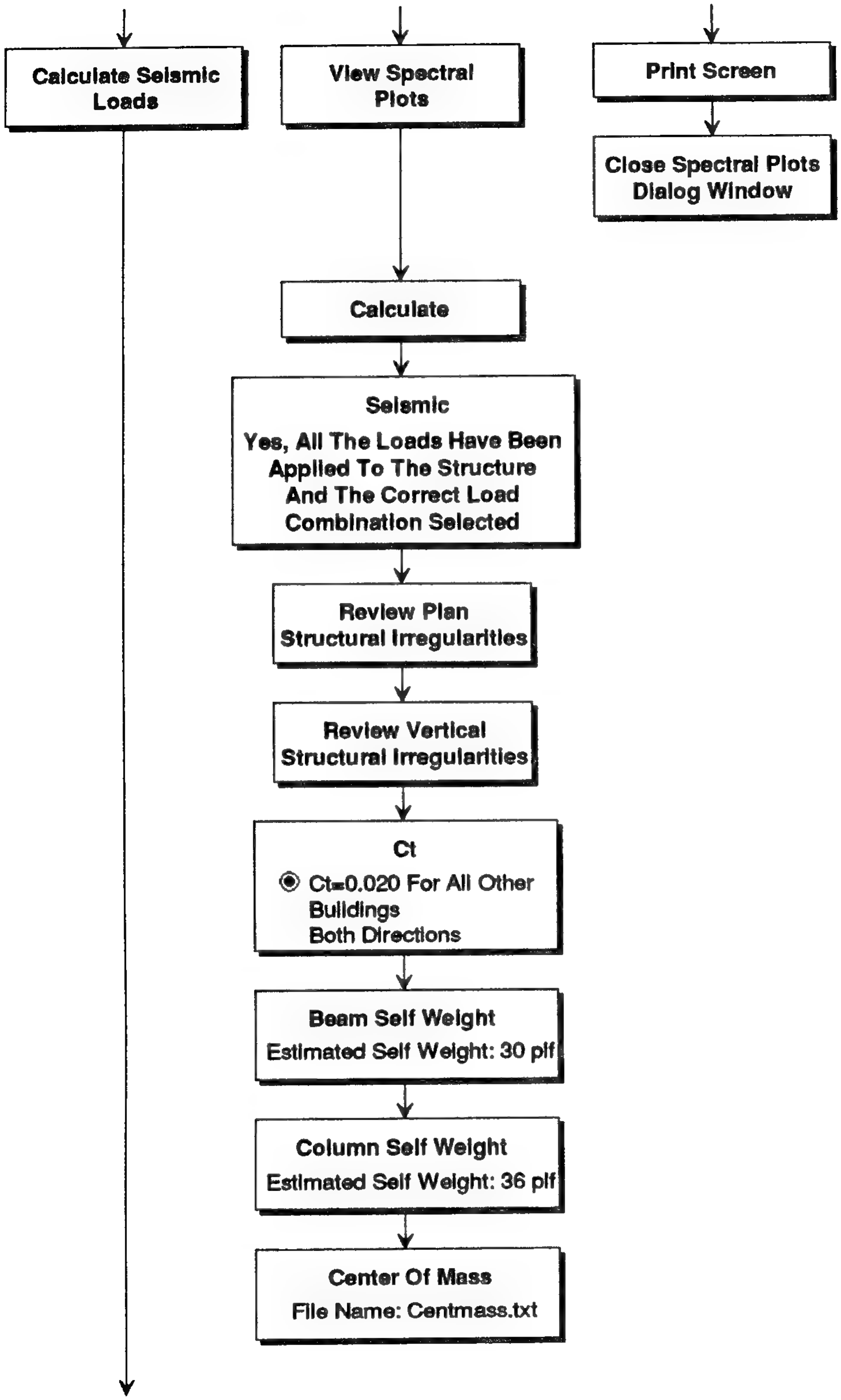
Assumptions used:
Deflections calculated by applying a 1000 k load.

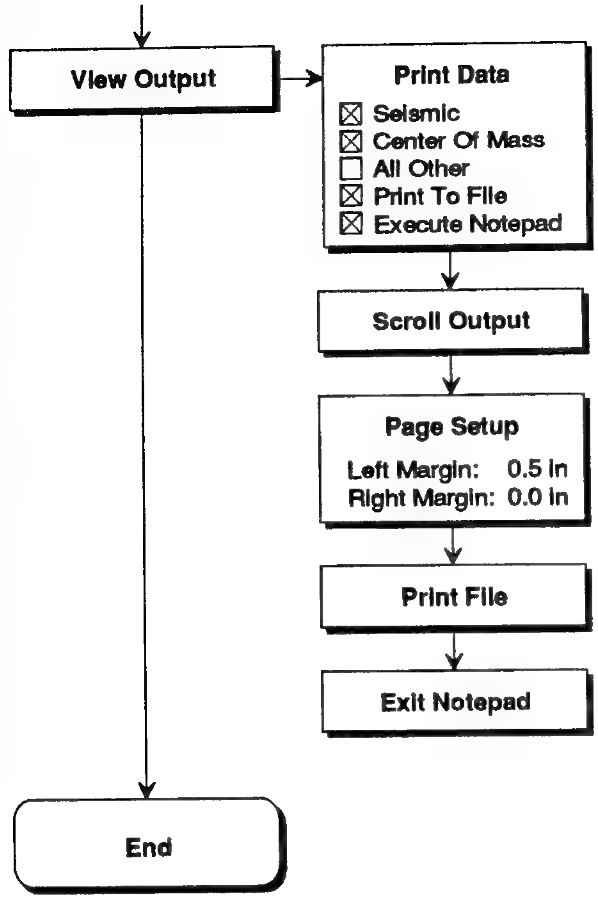
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	0.305	40.8	12.447	507.263	0.00705
NS-2	14.0	0.309	7.2	2.237	16.215	0.00127
NS-3	14.0	0.236	43.2	10.210	441.545	0.00578
EW-1	14.0	0.309	36.0	11.115	400.127	0.00630
EW-2	14.0	0.309	36.0	11.115	400.127	0.00630
Sum					1765.277	

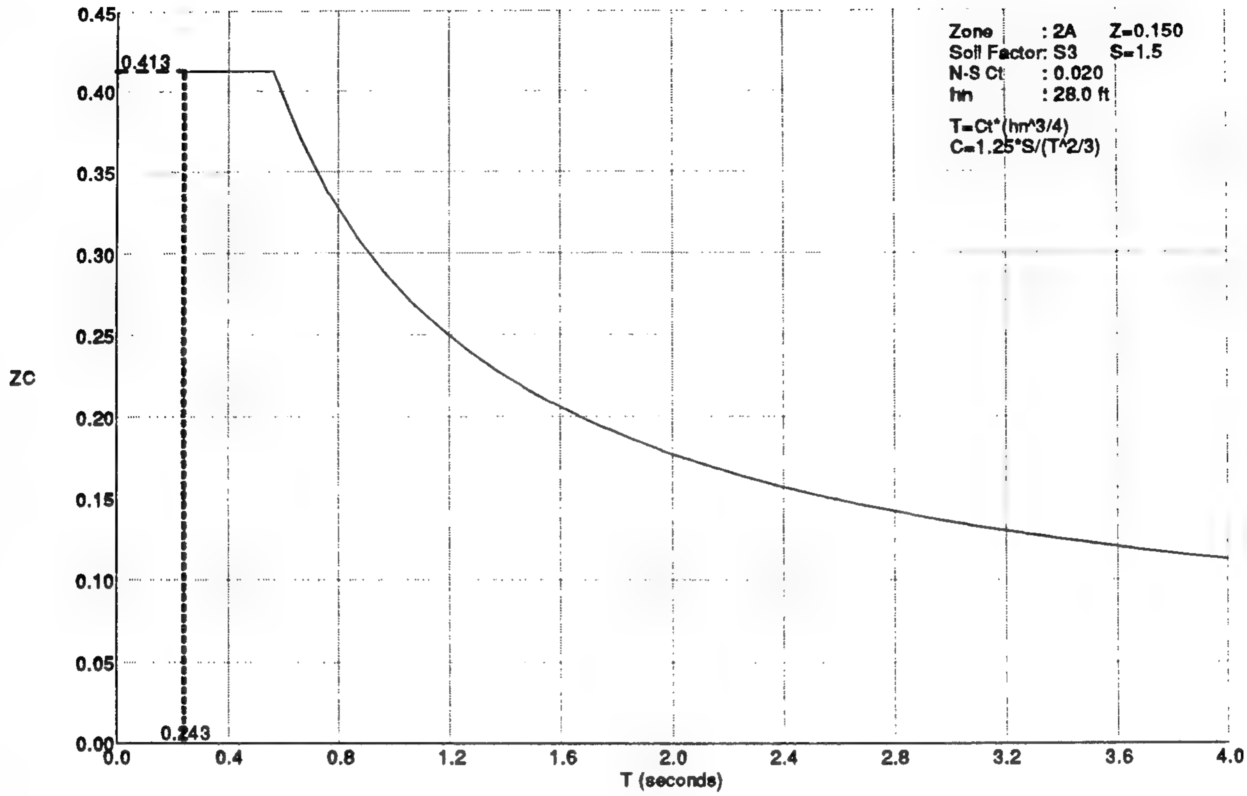
Shear distribution : Fv = V*R/sum(R)
Torsional moment : Mt = V*e
Torsional component : Ft = Mt*R*dx/sum(R*dx*dx)
Total shear to element: Ftotal = Fv + Ft

Seismic Loads

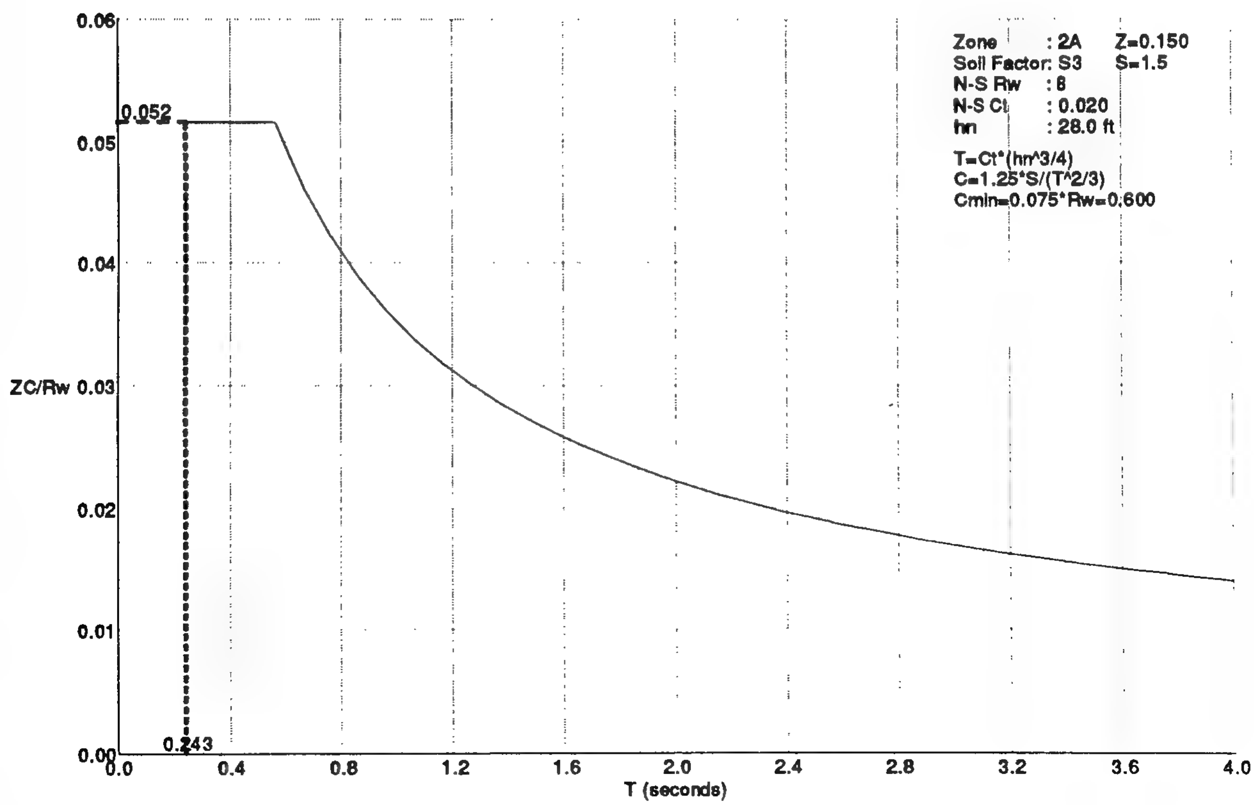



Calculate Seismic Loads
View Spectral Plots
Print Screen
Close Spectral Plots Dialog Window
Calculate
Seismic
Yes, All The Loads Have Been Applied To The Structure And The Correct Load Combination Selected
Review Plan Structural Irregularities
Review Vertical Structural Irregularities
Ct
Ct=0.020 For All Other Buildings
Both Directions
Beam Self Weight
Estimated Self Weight: 30 plf
Column Self Weight
Estimated Self Weight: 36 plf
Center Of Mass
File Name: Centmass.txt


View Output
Print Data
Seismic
Center Of Mass
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



N-S Base Shear Spectrum



N-S Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Seismic Code: TM 5-809-10 1992
Time         : Thu Sep 01, 1994  12:13 PM

**************************** Seismic Analysis *****************************

 3. Upper Roof                                      :     188.0 k
 2. Second Floor/Lower Roof                         :     670.3 k
----------------------------------------------------------------------
Total Building Weight (W)                           :     858.4 k

***************************** N - S and E - W *****************************

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: B4a: Rw = 8
Ct = 0.020
hn = 28.0 ft
T = Ct*hn^3/4 = 0.243 sec
C = 1.25*S/T^2/3 = 4.82 > 2.75
C = 2.75
C/Rw = 0.344 > 0.075
W = 858.4 k
V = Z*I*C*W/Rw
+--------------------------+
|       V = 44.3 k         |
+--------------------------+

T < 0.7 sec
+--------------------------+
|       Ft = 0.0 k         |
+--------------------------+

+--------------------------+
|     V-Ft = 44.3 k        |
+--------------------------+
```

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	w*h (kft)	w*h/ sum(w*h)	F (k)	sum(F) V (k)
						Ft =	0.0	
3	28.0		188		5264	0.359	15.9	
		14.0		188				15.9
2	14.0		670		9385	0.641	28.4	
		14.0		858				44.3
1	0.0							
Sum			858		14649	1.000	44.3	

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)	Ft+sum(F)/ sum(w)
3	28.0		188					
		14.0		188	15.9	223		0.085
2	14.0		670				223	
		14.0		858	44.3	620		0.052
1	0.0						842	
Sum			858			842		

Project : Office Building - Scheme B
Location : Radford AAP
Time : Thu Sep 01, 1994 12:13 PM

****************************** Center Of Mass ******************************

Upper Roof -- 28.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Exterior Wall	36.9	36.8	1358.9	0.8	30.7
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Upper Roof	49.8	36.8	1833.1	24.8	1235.9
Beam Self Weight	12.2	36.8	450.8	24.8	304.0
Column Self Weight	3.0	36.8	111.4	24.8	75.1
Sum	188.0		6924.9		4668.8

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 24.83 ft

Second Floor/Lower Roof -- 14.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	70.0	12.8	898.1	24.8	1737.9
Second Floor	58.3	36.8	2148.1	28.8	1681.6
Second Floor	70.0	60.8	4257.4	24.8	1737.9
Lower Roof	126.0	36.8	4639.9	66.8	8419.1
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Parapet	9.9	0.8	8.3	66.8	662.1
Parapet	19.8	36.8	729.8	84.8	1680.9
Parapet	9.9	72.8	721.6	66.8	662.1
Beam Self Weight	16.6	36.8	610.0	36.2	599.9
Column Self Weight	4.0	36.8	148.5	36.2	146.1
Exterior Wall	43.0	0.8	35.9	42.8	1843.6
Exterior Wall	36.9	36.8	1358.9	84.8	3129.7
Exterior Wall	43.0	72.8	3134.9	42.8	1843.6
Column Self Weight	3.0	36.8	111.4	24.8	75.1
Sum	670.3		24691.2		27304.4

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 40.73 ft

Seismic Lateral Analysis

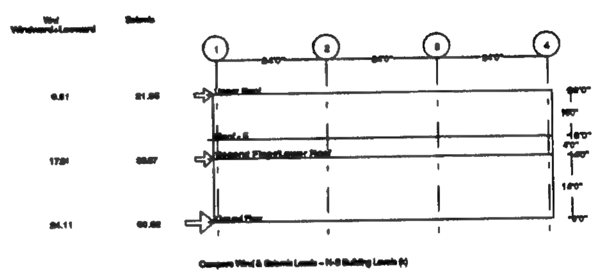
Start

Use Loads & Design Tool Palette

Define Member Properties → See Wind Lateral Analysis

Select Second Floor/ Lower Roof Horizontal Structural Plane

Compare Wind & Seismic Loads → Use Compare Wind & Seismic: N-S Building Levels → Compare Wind & Seismic



Load Combination D + E → Use Load Combination → Set Factors Dead: 1.0 Seismic: 1.0 → Add → OK Button To Close Dialog Window

Load Combination D + E → Highlight D+E In List

Lateral Analysis → Use Lateral Resistance Design

Lateral Analysis

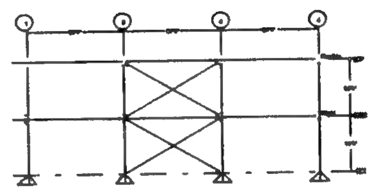
Select NS-1

Analysis
Units: Feet & Kips
Load Combination: D+E
☒ Use Actual Properties
☐ DL=Deck+Self Weight

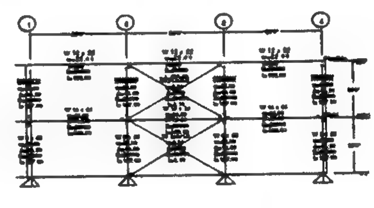
Connectivity
◉ Hinge

Repeat For All Supports

Lateral Resistance Verify X-Bracing Locations

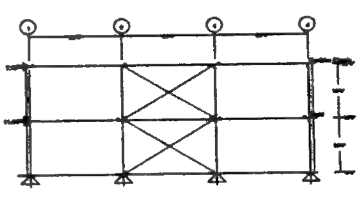


Yes, Properties Are All Correct



Flexible Diaphragm
◉ Simple Beam Model

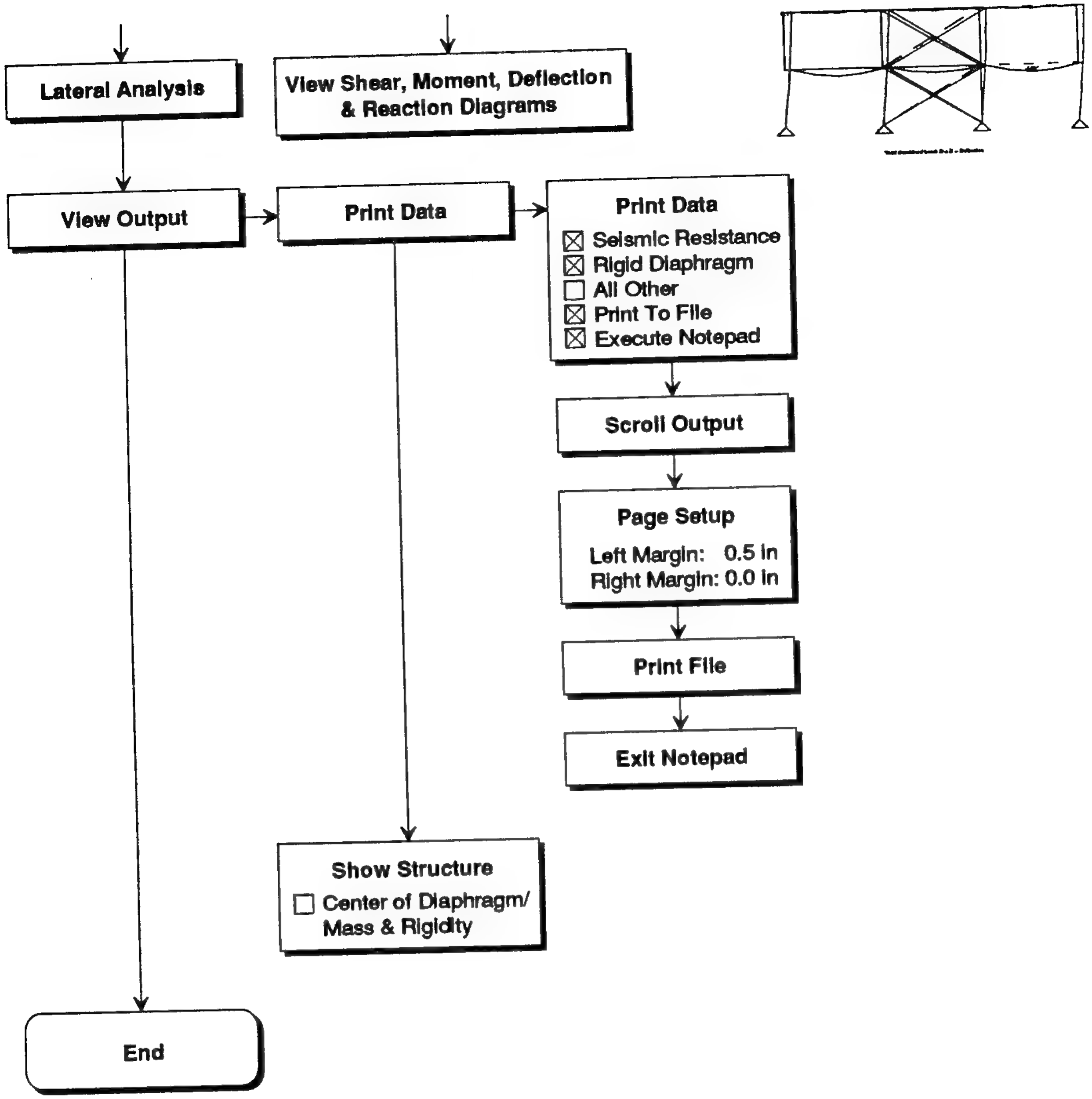
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level

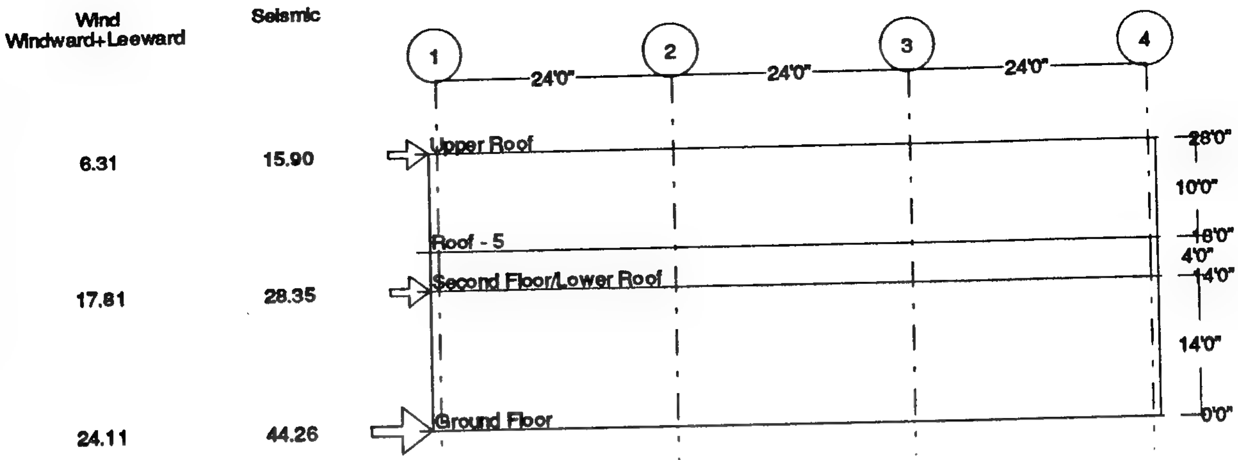


View Loads

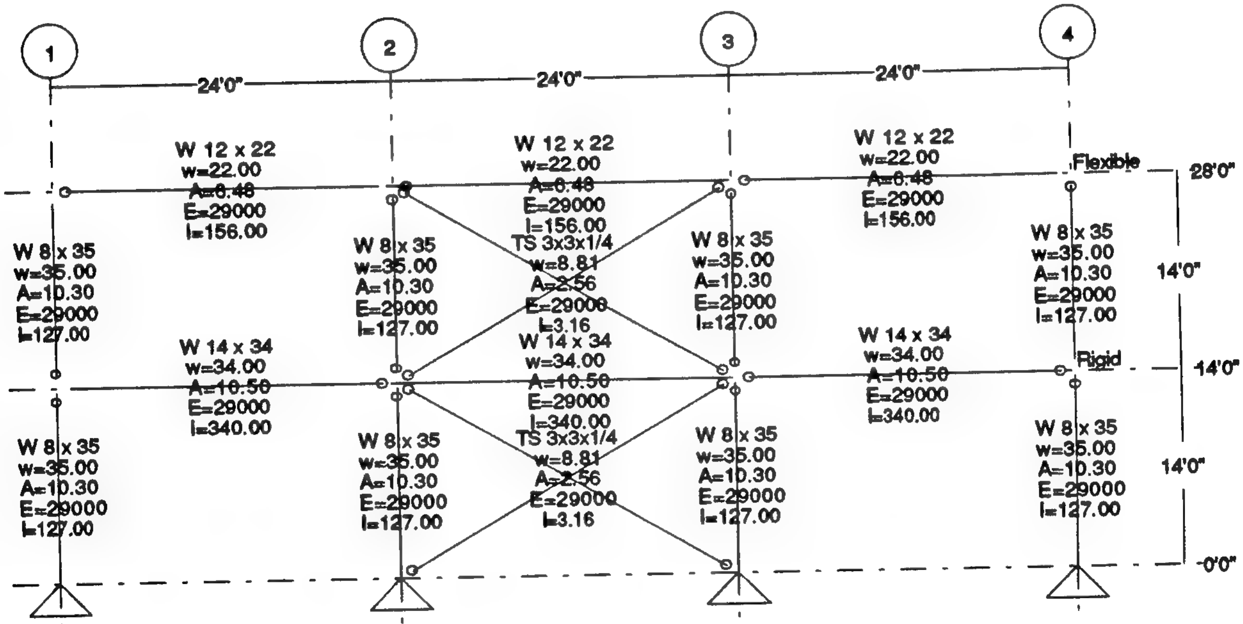
Seismic Lateral Resistance Locations
File Name: Latseis.txt

Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

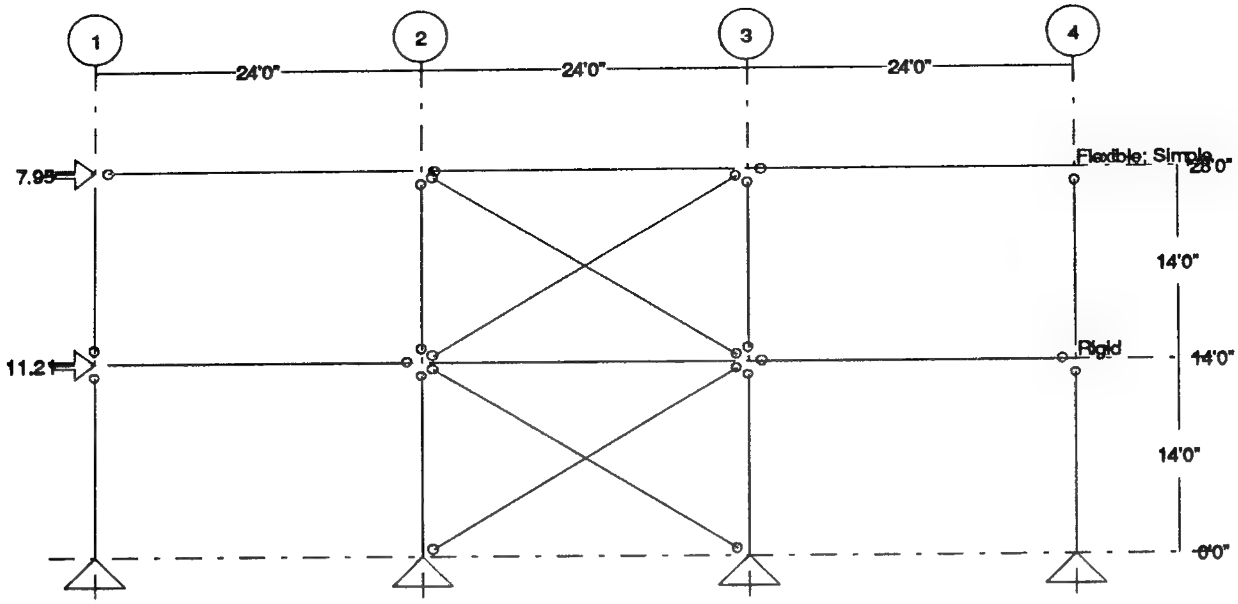

Lateral Analysis
View Shear, Moment, Deflection & Reaction Diagrams
View Output
Print Data
Print Data
☒ Seismic Resistance
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Show Structure
☐ Center of Diaphragm/ Mass & Rigidity
End



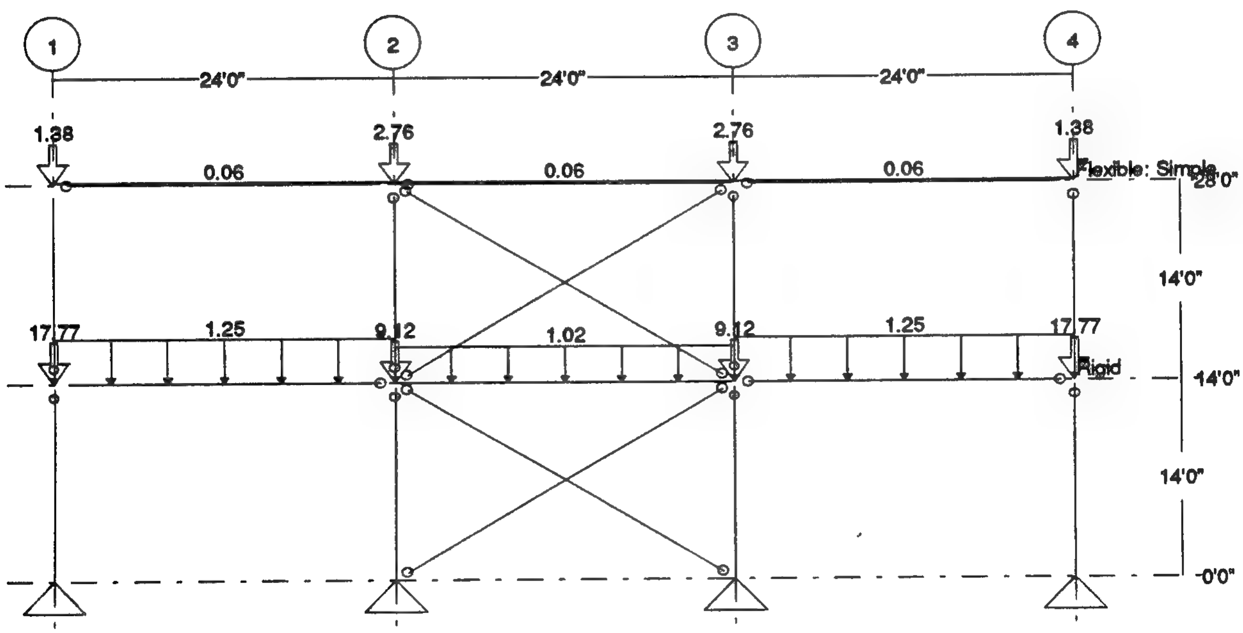
Compare Wind & Seismic Loads -- N-S Building Levels (k)



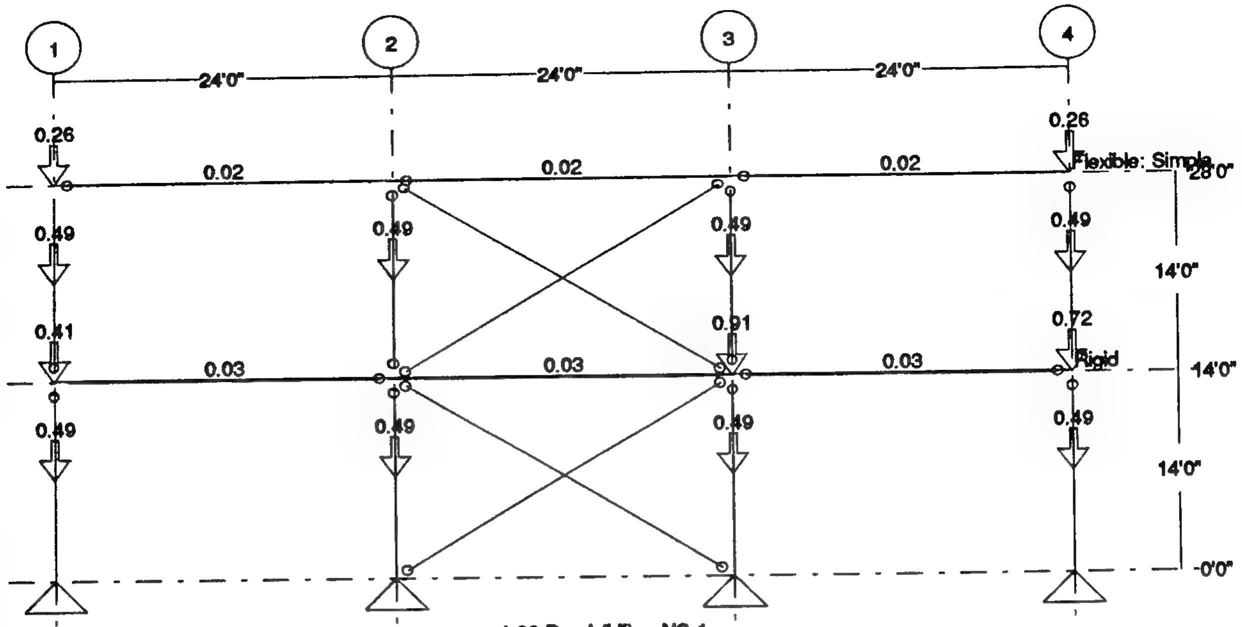
Properties: w (plf), A (in2), E (ksi), I (in4)



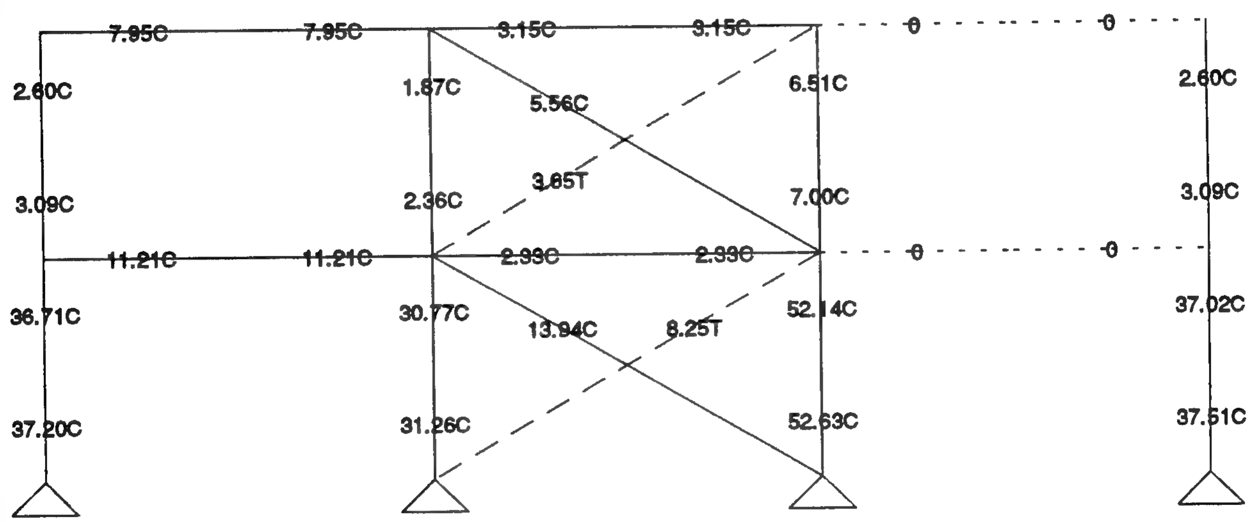
1.00 Seismic (klf) -- NS-1 -- F, 36%



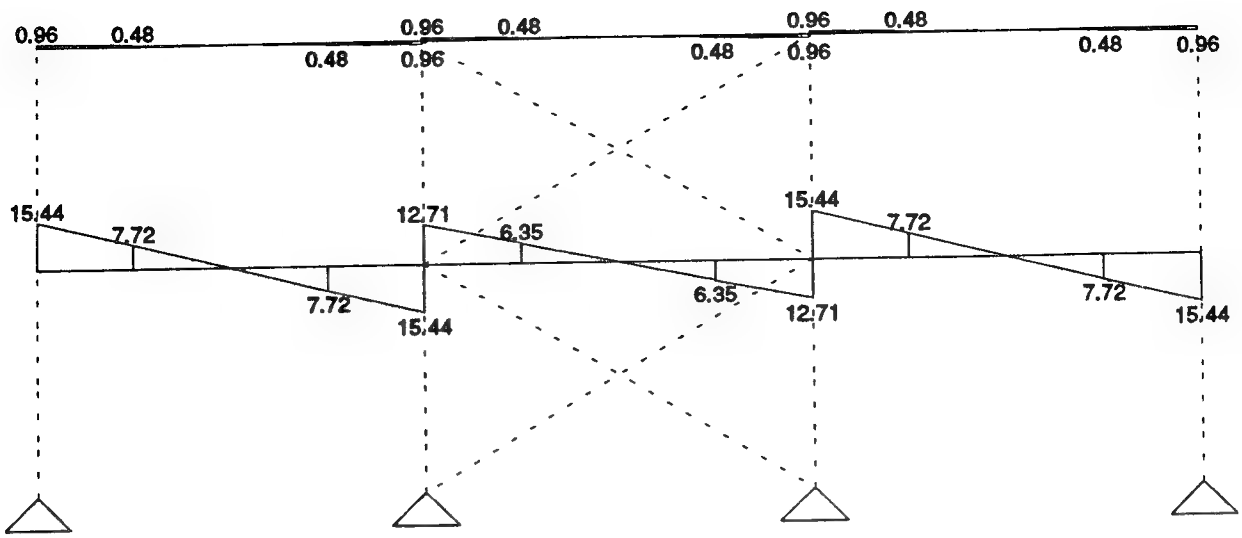
1.00 Superimposed Dead (klf) -- NS-1



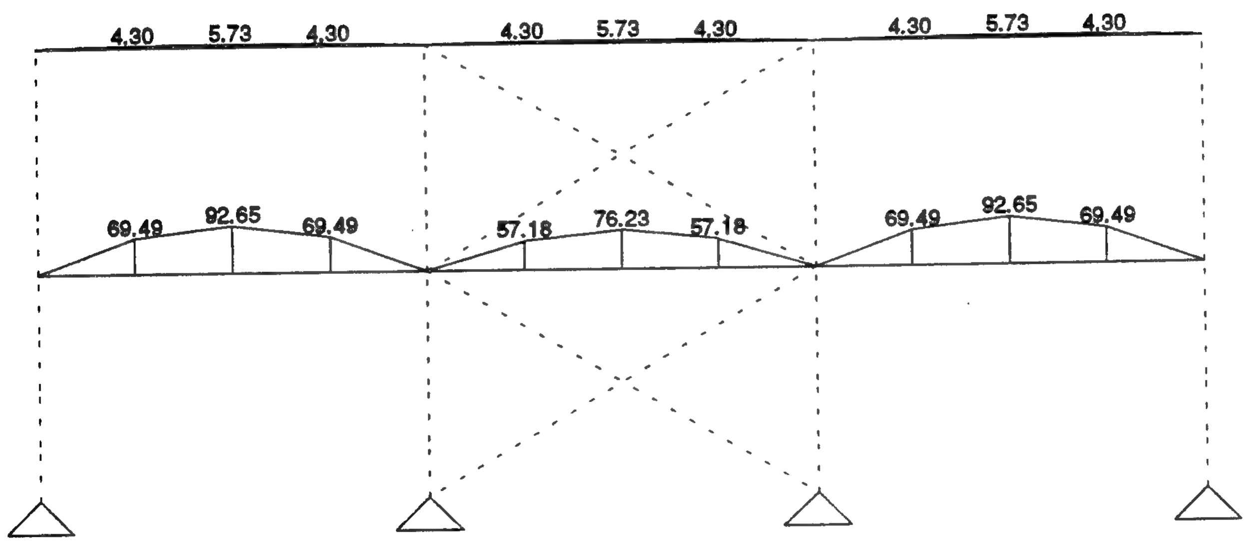
1.00 Dead (klf) -- NS-1



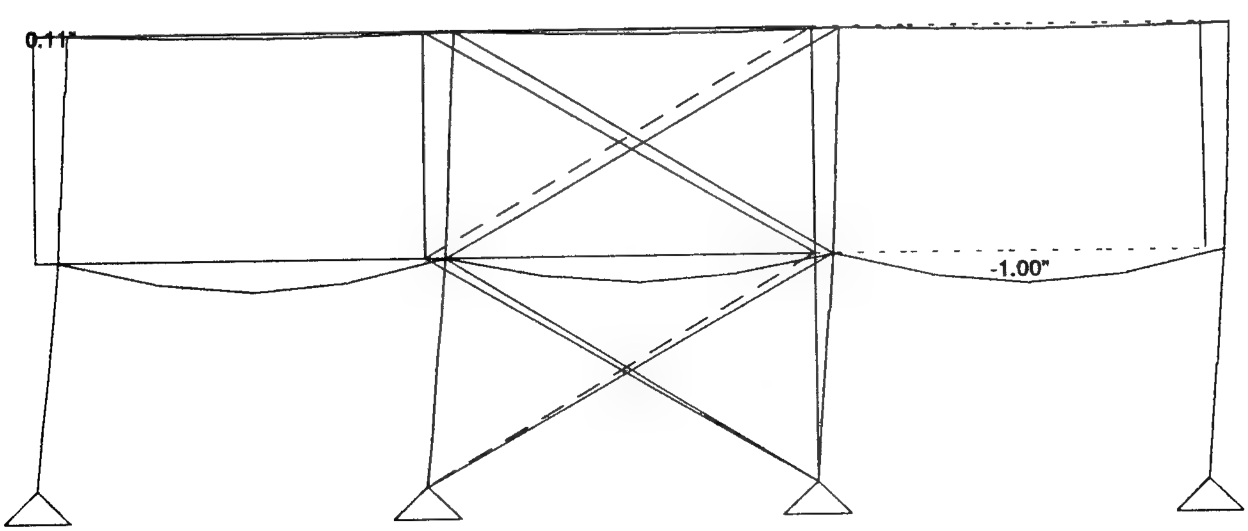
Total Combined Load: D + E -- Axial (k)



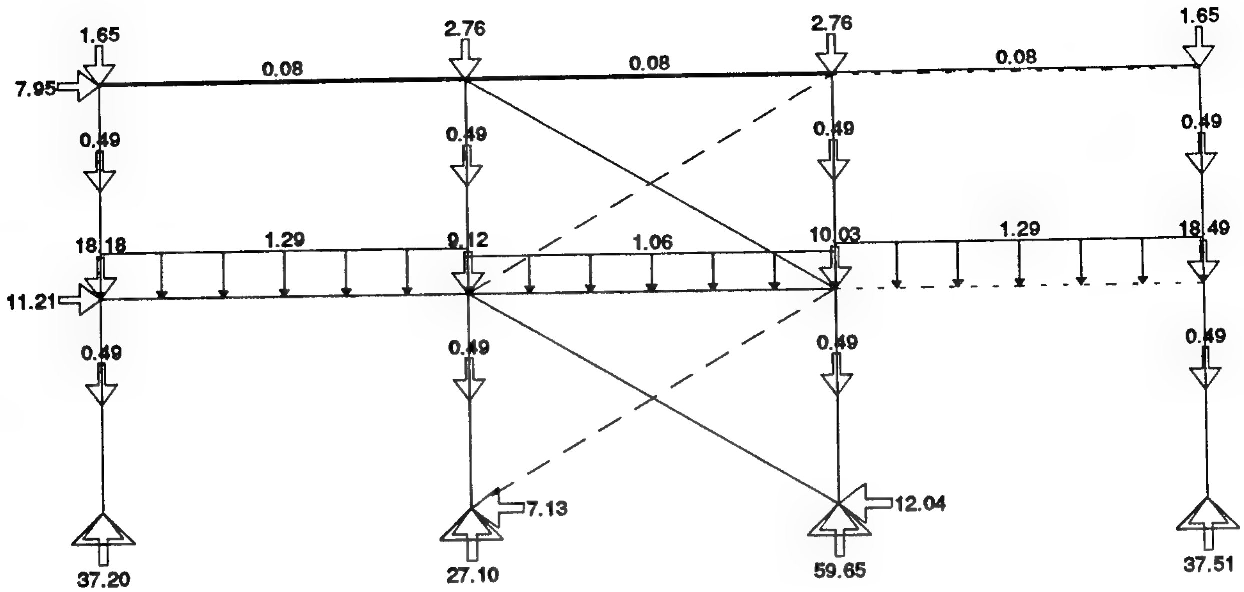
Total Combined Load: D + E -- Shear (k)



Total Combined Load: D + E -- Moment (ft-k)



Total Combined Load: D + E -- Deflection



Total Combined Load: D + E -- Loads & Reactions (k)

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Seismic Code: TM 5-809-10 1991
Time         : Sun Jan 26, 1992   6:12 PM
```

****************** Seismic Lateral Resistance Locations *******************

NS-1 — F, 36%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

NS-2 — F, 36%

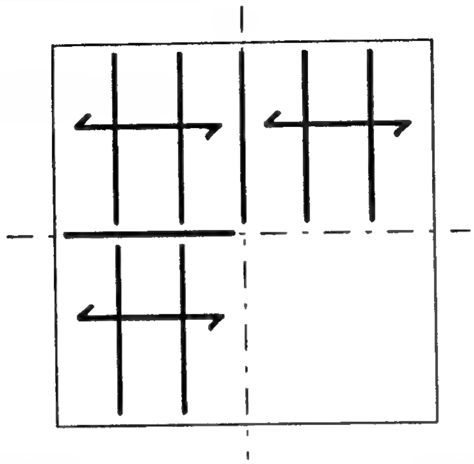
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

NS-3 — F, 28%						
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		28.4			
		14.0		28.4	397	
1	0.0					397
Sum			28.4		397	

Quantity Take-Off Philosophy

3 Considerations

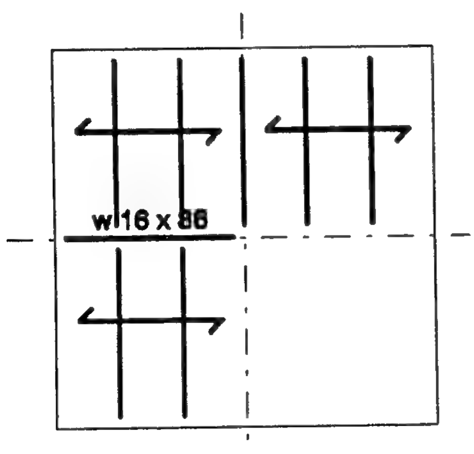
1. One typical interior bay   (exterior side bay, corner bay)



2 bays
by
2 bays

2. One typical floor level and roof level

3. The entire building structural system



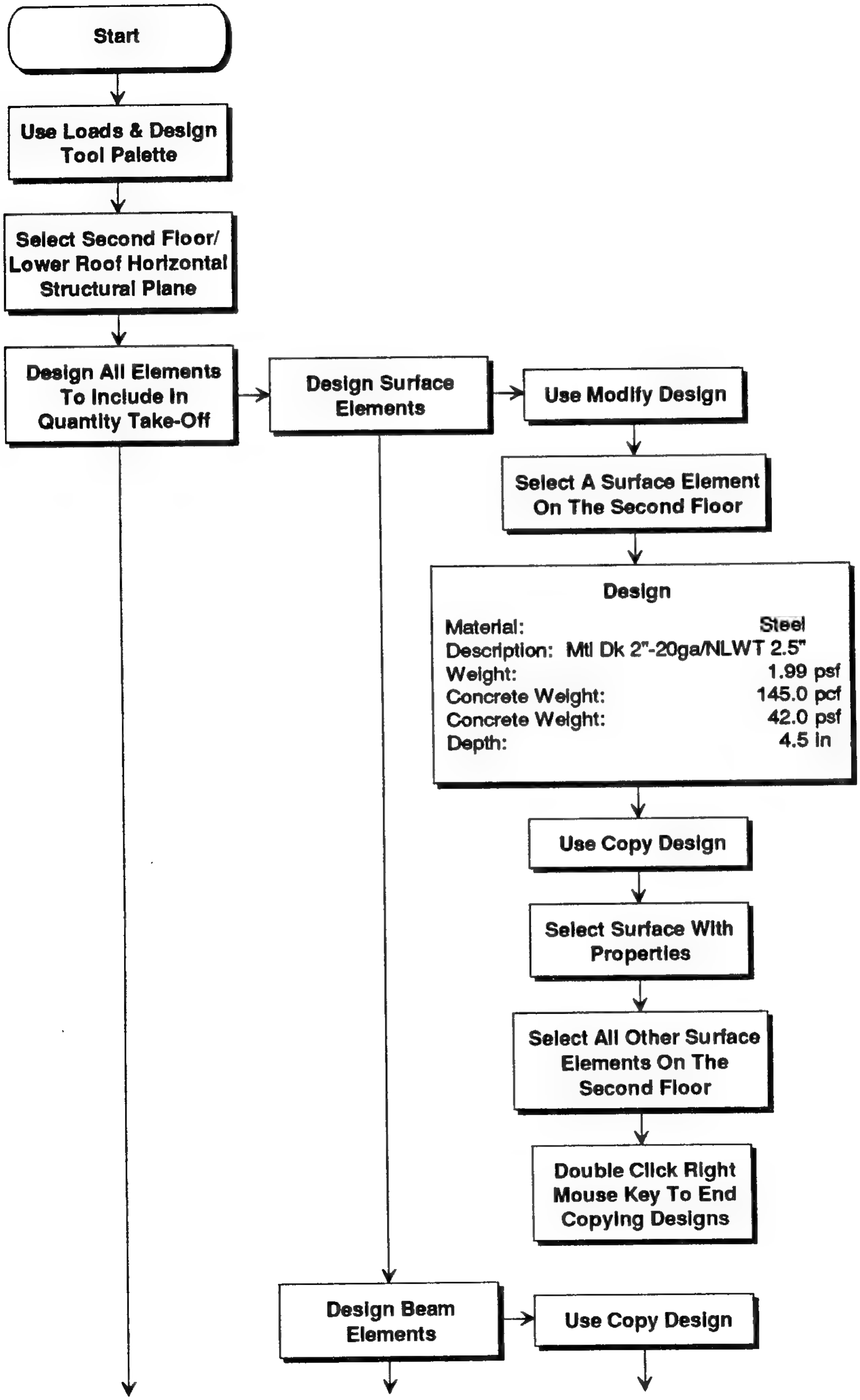
Estimated weights are not used for quantity take-offs

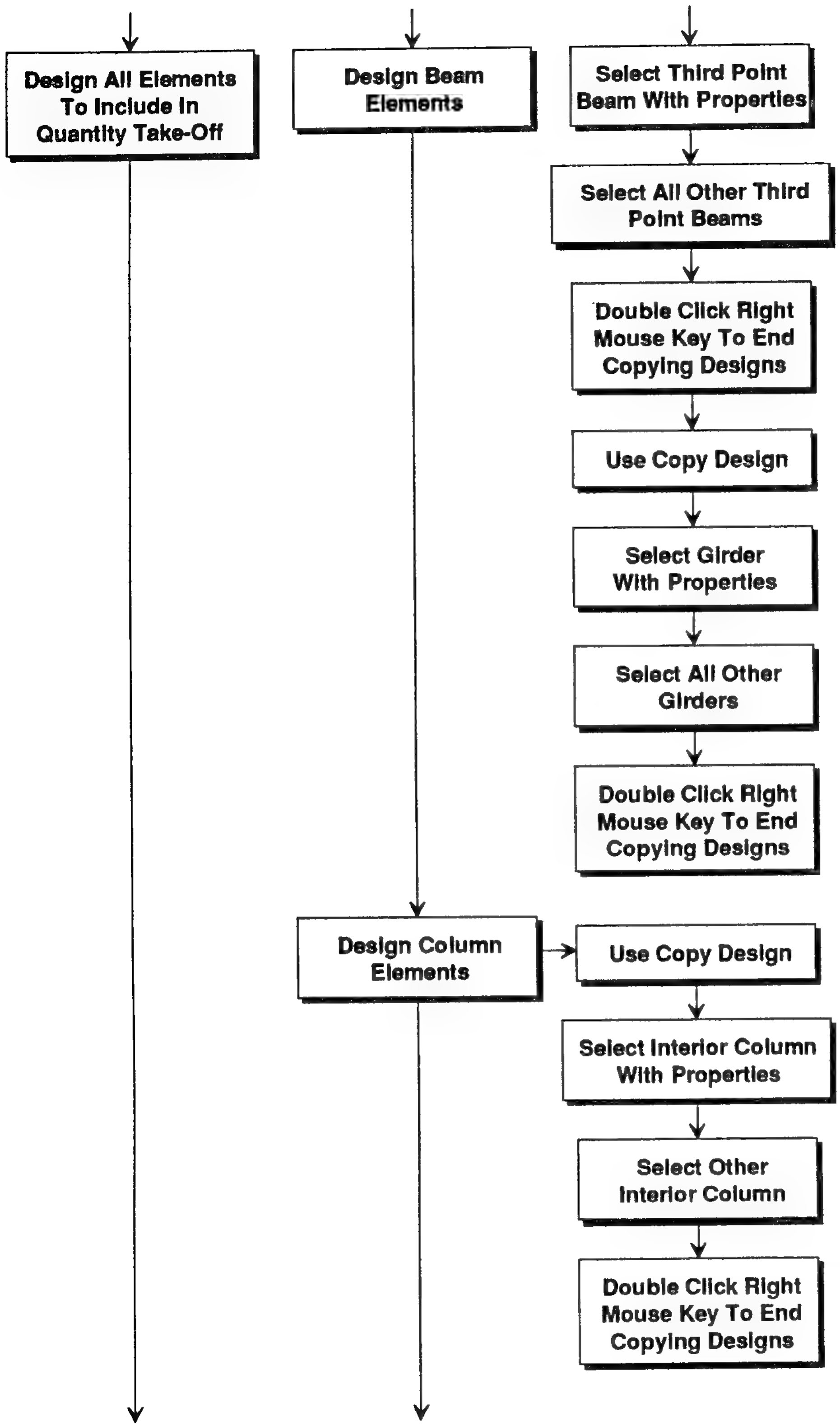
Elements designed by Excel spreadsheets are used

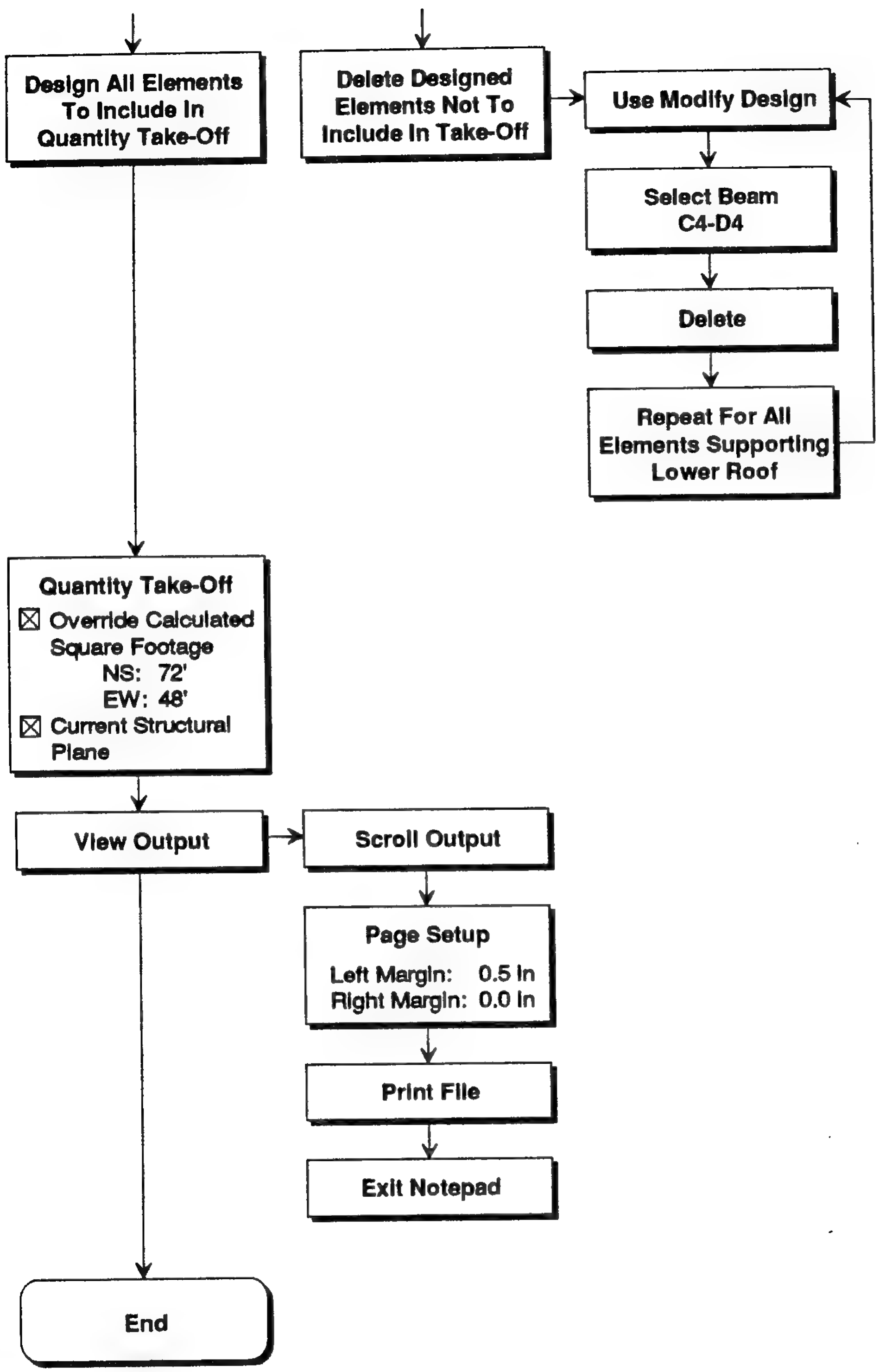
Use Modify Design and Copy Design to manually enter element sizes

Calculated square footage can be overridden

Quantity Take-Off




Design All Elements To Include In Quantity Take-Off
Design Beam Elements
Select Third Point Beam With Properties
Select All Other Third Point Beams
Double Click Right Mouse Key To End Copying Designs
Use Copy Design
Select Girder With Properties
Select All Other Girders
Double Click Right Mouse Key To End Copying Designs
Design Column Elements
Use Copy Design
Select Interior Column With Properties
Select Other Interior Column
Double Click Right Mouse Key To End Copying Designs


Design All Elements To Include In Quantity Take-Off
Delete Designed Elements Not To Include In Take-Off
Use Modify Design
Select Beam C4-D4
Delete
Repeat For All Elements Supporting Lower Roof
Quantity Take-Off
☒ Override Calculated Square Footage
NS: 72'
EW: 48'
☒ Current Structural Plane
View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Project : Office Building – Scheme B
Location : Radford AAP
Time : Sun Jan 26, 1992 6:30 PM

**************************** Quantity Take-off ****************************

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

STEEL: Narrowly Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
	36.0	0.0	0.0	17	0
Sum					0

Total Weight : 0.0 tons
Weight Per Square Foot : 0.0 psf

STEEL: Widely Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 14 x 34 (50)	24.0	34.0	816.0	10	8160
	36.0	0.0	0.0	2	0
W 21 x 50 (72)	24.0	50.0	1200.0	4	4800
W 16 x 26 (28)	24.0	26.0	624.0	15	9360
	24.0	0.0	0.0	3	0
Sum					22320

Total Weight : 11.2 tons
Weight Per Square Foot : 6.5 psf
Number of Shear Studs : 1208

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total (lbs)	Weight Conc (lbs)
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	2880	2.0	145.0	42.0	5731	120960
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	384	2.0	145.0	42.0	764	16128
	0.0	2592	0.0	0.0	0.0	0.	0
Sum						6495	137088

Concrete Cubic Yards : 35.0
Total Weight : 3.2 tons

STEEL: Column Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 8 x 35	14.0	35.0	490.0	10	4900
W 8 x 28	14.0	28.0	392.0	2	784
	14.0	0.0	0.0	4	0
Sum					5684

Total Weight : 2.8 tons
Weight Per Square Foot : 1.6 psf

Concluding Remarks

Schemes A, B and C were developed to permit exploration and instruction of the broadest possible range of CASM capabilities. The schemes should not be viewed as completely logical structural framing solutions to the given design parameters, nor as necessarily economical. Each of the three schemes contain a variety of elements, which if properly combined and interchanged might produce "real" schemes for consideration at a 35% review.

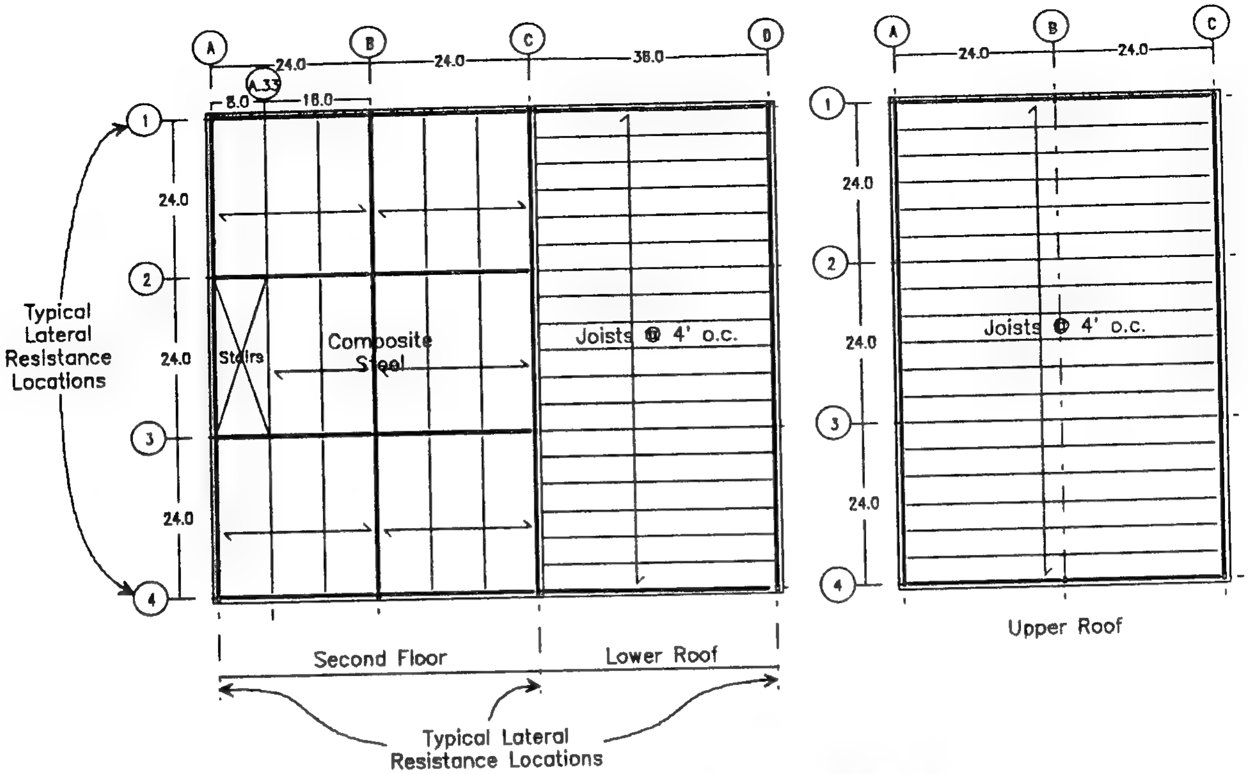
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the second floor.

A logical **steel framed beam/column** solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) as in scheme B. Both roofs would be sheathed with a metal roof deck without concrete and both would become flexible diaphragms. The second floor would be framed with composite steel beams as in scheme B and remain a rigid diaphragm. Two lateral load resistance system options could be compared. One scheme could include a moment resistant frame approach similar to scheme A, while a second approach might incorporate trussing similar to scheme B. The non-loadbearing exterior envelope is open to a variety of possibilities. The Architects will likely dictate the aesthetic expression. The foundation system would be a combination of isolated and linear spread footings.

A third logical solution would be a **masonry bearing wall** system to support the steel open-web joist roof planes described above. The second floor plane might be constructed of pre-cast pre-stressed hollow cored planks, which would also bear on the walls and a central steel girder line. Some of these walls could become shear walls for lateral load resistance. Thus the exterior envelope and the interior partition provide a structural function, eliminating costly moment connections and columns within the exterior wall layout. Footings are now all linear spread footings with only one isolated footing.

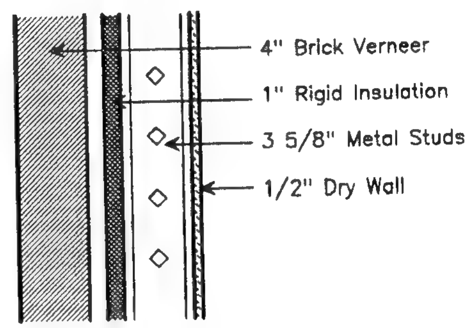
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

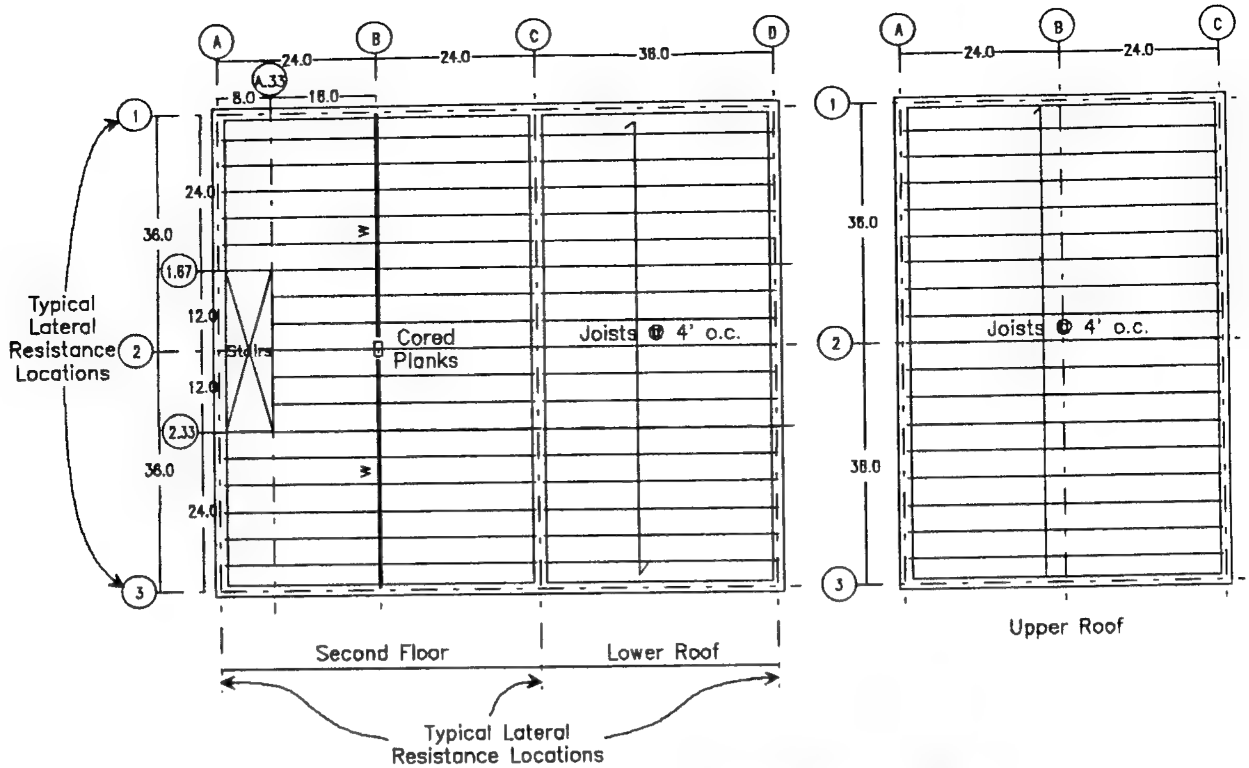
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

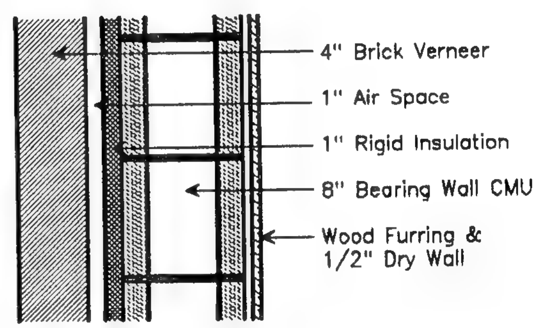
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



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13.ABSTRACT *(Maximum 200 words)*

The Computer-Aided Structural Modeling (CASM) computer program is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional (3-D) interactive graphics. CASM allows the structural engineer to quickly evaluate various framing alternatives in order to make more informed decisions in the initial structural evaluation process. The program was developed by the Information Technology Laboratory in conjunction with the Computer-Aided Structural Engineering (CASE) Project, Building Systems Task Group.

This release of the CASM is designed to aid the user with design criteria, building loads, and structural framing and design. The various parts of the program are summarized below.

a. Basic design criteria. The user can enter information directly or retrieve information from a user-definable database. The design criteria include information about the project, regional design information, and site-specific design information.

b. Building geometry. The user can assemble the building shape using 3-D primitives (cubes, prisms, spheres, cylinders, etc.) in an easy manner using pull-down menus, icons, and a mouse.

(Continued)

14.SUBJECT TERMS

Building systems	Preliminary structural design
Computer-Aided Structural Engineering (CASE)	Structural modeling
	3-Dimensional interactive graphics
Computer programs	3-Dimensional loads

15.NUMBER OF PAGES
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UNCLASSIFIED	UNCLASSIFIED		

13. (Concluded).

c. Dead and live loads. The user can select and construct dead and live loads from several user-definable menus of building materials and load conditions. These loads can then be applied to any desired area of the building volume.

d. Snow and wind loads. These loads are automatically calculated in 3-D using information from the basic design criteria database. Wind loads are also calculated for components and cladding and open roof structures. These loads are calculated in accordance with TM 5-809-1.

e. Seismic loads. These loads are calculated based on the equivalent static force method presented in TM 5-809-10.

f. Structural layout. The engineer can easily and rapidly experiment with various framing schemes inside the defined building volume. Beams, girders, joists, girts, columns, walls, and custom trusses are some of the structural elements that can be modeled.

g. Member analysis and preliminary sizing. The user can apply loads to the building geometry from a list of user-defined load cases. The shear, moment, and deflection of selected members may be calculated for various loading conditions (including pattern loads) and connectivity (including continuous beams). The design of a member is performed using a spreadsheet.

Data from the various investigated framing schemes can be edited and printed by CASM and used as justification in a design document.

This report describes the structural framing scheme for X-braced frames that are all steel, composite, with lateral load resistance.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
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Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980
	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
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	Report 1: Computational Processes	Feb 1981
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Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
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Technical Report ITL-90-3	Investigation and Design of U-Frame Structures Using Program CUFRBC	May 1990
	Volume A: Program Criteria and Documentation	
	Volume B: User's Guide for Basins	
	Volume C: User's Guide for Channels	
Instruction Report ITL-90-6	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame or W-Frame Structures (CWFRAM)	Sep 1990
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Technical Report ITL-92-7	Refined Stress Analysis of Melvin Price Locks and Dam	Sep 1992
Contract Report ITL-92-2	Knowledge-Based Expert System for Selection and Design of Retaining Structures	Sep 1992
Contract Report ITL-92-3	Evaluation of Thermal and Incremental Construction Effects for Monoliths AL-3 and AL-5 of the Melvin Price Locks and Dam	Sep 1992
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume IV, User's Manual	Nov 1992
Technical Report ITL-92-11	The Seismic Design of Waterfront Retaining Structures	Nov 1992
Technical Report ITL-92-12	Computer-Aided, Field-Verified Structural Evaluation	
	Report 1: Development of Computer Modeling Techniques for Miter Lock Gates	Nov 1992
	Report 2: Field Test and Analysis Correlation at John Hollis Bankhead Lock and Dam	Dec 1992
	Report 3: Field Test and Analysis Correlation of a Vertically Framed Miter Gate at Emsworth Lock and Dam	Dec 1993
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume III, Example Problems	Dec 1992
Technical Report ITL-93-1	Theoretical Manual for Analysis of Arch Dams	Jul 1993
Technical Report ITL-93-2	Steel Structures for Civil Works, General Considerations for Design and Rehabilitation	Aug 1993
Technical Report ITL-93-3	Soil-Structure Interaction Study of Red River Lock and Dam No. 1 Subjected to Sediment Loading	Sep 1993
Instruction Report ITL-93-3	User's Manual—ADAP, Graphics-Based Dam Analysis Program	Aug 1993
Instruction Report ITL-93-4	Load and Resistance Factor Design for Steel Miter Gates	Oct 1993
Technical Report ITL-94-2	User's Guide for the Incremental Construction, Soil-Structure Interaction Program SOILSTRUCT with Far-Field Boundary Elements	Mar 1994
Instruction Report ITL-94-1	Tutorial Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
Instruction Report ITL-94-2	User's Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
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Technical Report ITL-94-5	Procedure for Static Analysis of Gravity Dams Including Foundation Effects Using the Finite Element Method – Phase 1B	Jul 1994

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	Title	Date
Instruction Report ITL-94-5	User's Guide: Computer Program for Winkler Soil-Structure Interaction Analysis of Sheet-Pile Walls (CWALSSI)	Nov 1994
Instruction Report ITL-94-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Nov 1994
Instruction Report ITL-94-7	User's Guide to CTWALL – A Microcomputer Program for the Analysis of Retaining and Flood Walls	Dec 1994
Contract Report ITL-95-1	Comparison of Barge Impact Experimental and Finite Element Results for the Lower Miter Gate of Lock and Dam 26	Jun 1995
Technical Report ITL-95-5	Soil-Structure Interaction Parameters for Structured/Cemented Silts	Aug 1995
Instruction Report ITL-95-1	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITER-LRFD)	Aug 1995
Technical Report ITL-95-8	Constitutive Modeling of Concrete for Massive Concrete Structures, A Simplified Overview	Sep 1995
Instruction Report ITL-96-1	User's Guide: Computer Program for Two-Dimensional Dynamic Analysis of U-Frame or W-Frame Structures (CDWFRM)	Jun 1996
Instruction Report ITL-96-2	Computer-Aided Structural Modeling (CASM), Version 6.00 Report 1: Tutorial Guide Report 2: User's Guide Report 3: Scheme A Report 4: Scheme B Report 5: Scheme C	Jun 1996
Instruction Report ITL-96-	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITERW-LRFD) Windows Version	Jul 1996